



NC State University

Doak Field Enhancements

1081 VARSITY DR | RALEIGH | NORTH CAROLINA 27606

Project Manual – Volume 1 (Divisions 1-14) Construction Documents

SCO CONTRACT NUMBER: 22-24384-01A
NC STATE PROJECT NUMBER: 202120015
EWINGCOLE PROJECT NUMBER: 20220400

January 29, 2024

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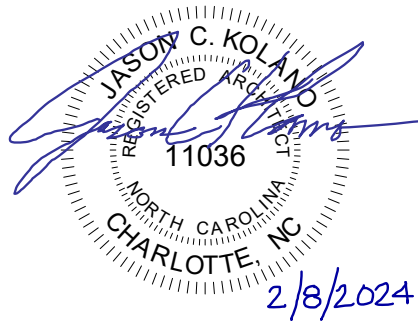
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1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. EwingCole
2. Jason C. Kolano
3. 11036 (North Carolina)
4. Responsible for Division 00-49 and referenced drawings in Construction Documents issuance, except where indicated as prepared by other design professionals of record.



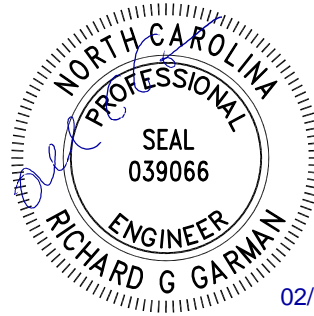
B. Civil/Landscape Engineer:

1. McAdams
2. James Eason
3. 042597 (North Carolina)
4. Responsible for sections:
 - a. 02 41 13 Selective Site Removal
 - b. 32 10 00 Site Clearing
 - c. 31 20 00 Earth Moving
 - d. 31 23 17 Trenching
 - e. 31 23 19 Dewatering
 - f. 31 23 24 Flowable Fill
 - g. 31 25 00 Erosion and Sedimentation Control
 - h. 33 11 00 Water Utility Drainage Piping
 - i. 33 30 00 Sanitary Sewer Utility Distribution System
 - j. 33 41 00 Storm Utility Drainage Piping
 - k. 33 49 13 Storm Drainage Structures



C. Electrical Engineer:

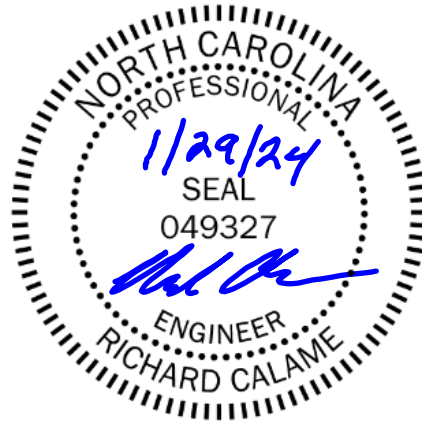
1. Ewing Cole
2. Richard Garman
3. 039066 (North Carolina)
4. Responsible for:
 - a. Division 26 Sections
 - b. Section 28 31 11 "Digital, Addressable Fire Detection and Alarm System"



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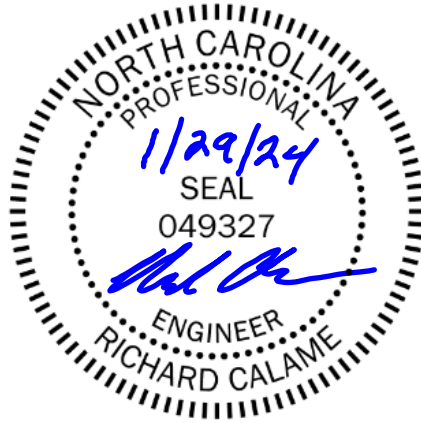
D. Mechanical Engineer:

1. EwingCole
2. Richard Calame
3. 049327 (North Carolina)
4. Responsible for Division 23



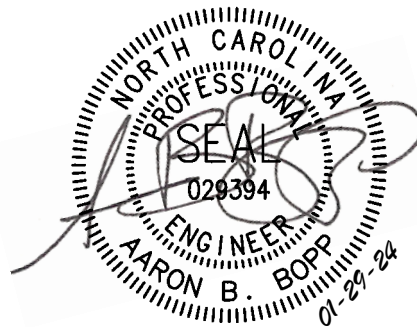
E. Plumbing Engineer:

1. EwingCole
2. Richard Calame
3. 049327 (North Carolina)
4. Responsible for Division 22



F. Structural Engineer:

1. SKA Consulting Engineers
2. Aaron B. Bopp
3. 029394 (North Carolina)
4. Responsible for Sections:
 - a. 01 41 00 Special Inspections
 - b. 01 41 01 Statement of Special Inspections
 - c. 03 10 00 Concrete Formwork
 - d. 03 20 00 Concrete Reinforcement
 - e. 03 25 00 Adhesive Anchors
 - f. 03 30 00 Cast in Place Concrete
 - g. 05 12 00 Structural Steel
 - h. 05 31 00 Steel Decking



G. Low Voltage:

1. WHJW
2. Todd Semple
- 3.
4. Responsible for: Divisions 27 and 28.

END OF DOCUMENT 00 01 07

SECTION 00 01 15 - DRAWING LIST

Drawings consist of the Contract Drawings and other drawings listed on the Table of Contents page of the separately bound drawing set included on Drawing CS.A, dated January 29, 2024, as modified by subsequent Addenda and Contract modifications, form a part of the contract documents.

END OF SECTION 00 01 15

DOCUMENT 00 11 16 - INVITATION TO BID

1.1 PROJECT INFORMATION

- A. Notice to Bidders: Prequalified bidders are invited to submit bids for Project as described in this Document according to the Instructions to Bidders.
- B. Project Identification: Doak Field Enhancements, Phase 2
1. Project Location: 1081 Varsity Dr., Raleigh, NC 27606
 2. State Construction Office Project No.: 22-24384-01
 3. NC State University Project No.: 202120015
 4. Designer Project No.: 20220400
- C. Owner: State of North Carolina
1. Owning Agency: North Carolina State University, Raleigh, NC
 - a. Point of Contact (Design Phase): Robert Cwikla; (919) 515-6836;
rmcwikla@ncsu.edu.
 - b. Point of Contact (Construction Phase): Mark Michaelson; (919) 513-2752;
mjmichae@ncsu.edu.
 - c. Department: Capital Project Management, Design and Construction
Administrative Services Building III
2601 Wolf Village Way, Suite 331
Raleigh, NC 27695-7520
Campus Box 7520
- D. Architect: EwingCole
Architects.Engineers.Interior Designers.Planners
Federal Reserve Bank Building
100 N. 6th Street
Independence Mall West
Philadelphia, Pennsylvania 19106
215-923-2020

8208 Brownleigh Drive, Suite 200
Raleigh, NC 27617
919-460-6700
- E. Construction Manager: Romeo Guest, A New South Company.

1715 Camden Ave
Durham, NC 27704
919-683-1701
- F. Project Description: Project consists of additions to and alterations of Doak Field at Dail Park, an NCAA baseball stadium on the campus of NC State University. Work areas are as follows:

1. Area A: A 17,000 square-foot addition to the existing Doak Field baseball operations center, containing player training, locker room, and lounge facilities, and extending spectator circulation, seating, and concessions.
2. Area B: Terraced grandstand seating along the third base line with a 1,600 square-foot new construction concession building, adjoining entry gate, and accompanying sitework.

G. Construction Contract: Bids will be received for the following Work:

1. Multiple Contract Project consisting of prime contracts as administered by the Construction Manager.

1.2 BID SUBMITTAL AND OPENING

- A. Owner will receive sealed bids until the advertised bid time and date at the location indicated in the advertisement. Owner will consider bids prepared in compliance with the Instructions to Bidders issued by Owner, and delivered as directed in the advertisement.
- B. Bids will be thereafter publicly opened and read aloud.

1.3 BID SECURITY

- A. Bid security shall be submitted with each bid in the amount specified by the Owner and Construction Manager. No bids may be withdrawn for a period of time after opening of bids as specified by the Owner and Construction Manager. Owner reserves the right to reject any and all bids and to waive informalities and irregularities.

1.4 PREBID CONFERENCE

- A. A pre-bid conference for all bidders will be held at a time and location as publicly advertised. Prospective bidders are requested to attend.

1.5 DOCUMENTS

- A. Printed Procurement and Contracting Documents: Obtain by contacting Construction Manager, or as otherwise directed in the advertisement. Documents will be provided to prime bidders only; only complete sets of documents will be issued.
- B. Online Procurement and Contracting Documents: Obtain access by contacting Constructino Manager. Online access will be provided according to the advertisement.

1.6 TIME OF COMPLETION

- A. Bidders shall begin the Work on receipt of the Notice to Proceed and shall complete the Work within the Contract Time.

1.7 BIDDER'S QUALIFICATIONS

- A. Bidders must be prequalified by Owner and Construction Manager.
- B. Bidders must be properly licensed under the laws governing their respective trades and be able to obtain insurance and bonds required for the Work. A Performance Bond, a separate Labor and Material Payment Bond, and Insurance in a form acceptable to Owner and compliant with the requirements of State Construction Office form OC-15 will be required of the successful Bidder.

END OF DOCUMENT 00 11 16

**INSTRUCTIONS TO BIDDERS
AND
GENERAL CONDITIONS OF THE CONTRACT**

STANDARD FORM FOR CONSTRUCTION PROJECTS

**STATE CONSTRUCTION OFFICE
NORTH CAROLINA
DEPARTMENT OF ADMINISTRATION**

Form OC-15

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.

Twenty Fourth Edition January 2013

INSTRUCTIONS TO BIDDERS

For a proposal to be considered it must be in accordance with the following instructions:

1. PROPOSALS

Proposals must be made in strict accordance with the Form of Proposal provided therefor, and all blank spaces for bids, alternates, and unit prices applicable to bidder's work shall be properly filled in. When requested alternates are not bid, the proposer shall so indicate by the words "No Bid". Any blanks shall also be interpreted as "No Bid". The bidder agrees that bid on Form of Proposal detached from specifications will be considered and will have the same force and effect as if attached thereto. Photocopied or faxed proposals will not be considered. Numbers shall be stated both in writing and in figures for the base bids and alternates. If figures and writing differ, the written number will supersede the figures.

Any modifications to the Form of Proposal (including alternates and/or unit prices) will disqualify the bid and may cause the bid to be rejected.

The bidder shall fill in the Form of Proposal as follows:

- a. 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.
- b. 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.
- c. 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.
- d. If the proposal is made by a joint venture, it shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable.
- e. All signatures shall be properly witnessed.
- f. If the contractor's license of a bidder 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 proposal. The title "Licensee" shall appear under his/her signature.

Proposals should be addressed as indicated in the Advertisement for Bids and be delivered, enclosed in an opaque sealed envelope, marked "Proposal" and bearing the title of the work, name of the bidder, and the contractor's license number of the bidder. Bidders should clearly mark on the outside of the bid envelope which contract(s) they are bidding.

Bidder shall identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts or an affidavit indicating work under contract will be self-performed, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f). Failure to comply with these requirements is grounds for rejection of the bid.

For projects bid in the single-prime alternative, the names and license numbers of major subcontractors shall be listed on the proposal form.

It shall be the specific responsibility of the bidder to deliver his bid to the proper official at the selected place and prior to the announced time for the opening of bids. Later delivery of a bid for any reason, including delivery by any delivery service, shall disqualify the bid.

Unit prices quoted in the proposal shall include overhead and profit and shall be the full compensation for the contractor's cost involved in the work. See General Conditions, Article 19c-1.

2. EXAMINATION OF CONDITIONS

It is understood and mutually agreed that by submitting a bid the bidder acknowledges that he has carefully examined all documents pertaining to the work, the location, accessibility and general character of the site of the work and all existing buildings and structures within and adjacent to the site, and has satisfied himself as to the nature of the work, the condition of existing buildings and structures, the conformation of the ground, the character, quality and quantity of the material to be encountered, the character of the equipment, machinery, plant and any other facilities needed preliminary to and during prosecution of the work, the general and local conditions, the construction hazards, and all other matters, including, but not limited to, the labor situation which can in any way affect the work under the contract, and including all safety measures required by the Occupational Safety and Health Act of 1970 and all rules and regulations issued pursuant thereto. It is further mutually agreed that by submitting a proposal the bidder acknowledges that he has satisfied himself as to the feasibility and meaning of the plans, drawings, specifications and other contract documents for the construction of the work and that he accepts all the terms, conditions and stipulations contained therein; and that he is prepared to work in cooperation with other contractors performing work on the site.

Reference is made to contract documents for the identification of those surveys and investigation reports of subsurface or latent physical conditions at the site or otherwise affecting performance of the work which have been relied upon by the designer in preparing the documents. The owner will make copies of all such surveys and reports available to the bidder upon request.

Each bidder may, at his own expense, make such additional surveys and investigations as he may deem necessary to determine his bid price for the performance of the work. Any on-site investigation shall be done at the convenience of the owner. Any reasonable request for access to the site will be honored by the owner.

3. BULLETINS AND ADDENDA

Any addenda to specifications issued during the time of bidding are to be considered covered in the proposal and in closing a contract they will become a part thereof. It shall be the bidder's responsibility to ascertain prior to bid time the addenda issued and to see that his bid includes any changes thereby required.

Should the bidder find discrepancies in, or omission from, the drawings or documents or should he be in doubt as to their meaning, he shall at once notify the designer who will send written instructions in the form of addenda to all bidders. Notification should be no later than seven (7) days prior to the date set for receipt of bids. Neither the owner nor the designer will be responsible for any oral instructions.

All addenda should be acknowledged by the bidder(s) on the Form of Proposal. However, even if not acknowledged, by submitting a bid, the bidder has certified that he has reviewed all issued addenda and has included all costs associated within his bid.

4. BID SECURITY

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company insured by the Federal Deposit Insurance Corporation, or a bid bond in an amount equal to not less than five percent (5%) of the proposal, said deposit to be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten (10) days after the award or to give satisfactory surety as required by law (G.S. 143-129).

Bid bond shall be conditioned that the surety will, upon demand, forthwith make payment to the obligee upon said bond if the bidder fails to execute the contract. The owner may retain bid securities of any bidder(s) who may have a reasonable chance of award of contract for the full duration of time stated in the Notice to Bidders. Other bid securities may be released sooner, at the discretion of the owner. All bid securities (cash or certified checks) shall be returned to the bidders promptly after award of contracts, and no later than seven (7) days after expiration of the holding period stated in the Notice to Bidders. Standard Form of Bid Bond is included in these specifications and shall be used.

5. RECEIPT OF BIDS

Bids shall be received in strict accordance with requirements of the General Statutes of North Carolina. Bid security shall be required as prescribed by statute. Prior to the closing of the bid, the bidder will be permitted to change or withdraw his bid. Guidelines for opening of public construction bids are available from the State Construction Office.

6. OPENING OF BIDS

Upon opening, all bids shall be read aloud. Once bidding is closed, there shall not be any withdrawal of bids by any bidder and no bids may be returned by the designer to any bidder. After the opening of bids, no bid may be withdrawn, except under the provisions of General Statute 143-129.1, for a period of thirty days unless otherwise specified. Should the successful bidder default and fail to execute a contract, the contract may be awarded to the next lowest and responsible bidder. The owner reserves the unqualified right to reject any and all bids. Reasons for rejection may include, but shall not be limited to, the following:

- a. If the Form of Proposal furnished to the bidder is not used or is altered.
- b. If the bidder fails to insert a price for all bid items, alternate and unit prices requested.
- c. If the bidder adds any provisions reserving the right to accept or reject any award.
- d. If there are unauthorized additions or conditional bids, or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- e. If the bidder fails to complete the proposal form where information is requested so the bid may be properly evaluated by the owner.
- f. If the unit prices contained in the bid schedule are unacceptable to the owner and the State Construction Office.
- g. If the bidder fails to comply with other instructions stated herein.

7. BID EVALUATION

The award of the contract will be made to the lowest responsible bidder as soon as practical. The owner may award on the basis of the base bid and any alternates the owner chooses.

Before awarding a contract, the owner may require the apparent low bidder to qualify himself to be a responsible bidder by furnishing any or all of the following data:

- a. The latest financial statement showing assets and liabilities of the company or other information satisfactory to the owner.
- b. A listing of completed projects of similar size.
- c. Permanent name and address of place of business.
- d. The number of regular employees of the organization and length of time the organization has been in business under present name.
- e. The name and home office address of the surety proposed and the name and address of the responsible local claim agent.
- f. The names of members of the firms who hold appropriate trade licenses, together with license numbers.
- g. If prequalified, contractor info will be reviewed and evaluated comparatively to submitted prequalification package.

Failure or refusal to furnish any of the above information, if requested, shall constitute a basis for disqualification of any bidder.

In determining the lowest responsible, responsive bidder, the owner shall take into consideration the bidder's compliance with the requirements of G.S. 143-128.2(c), the past performance of the bidder on construction contracts for the State with particular concern given to completion times, quality of work, cooperation with other contractors, and cooperation with the designer and owner. Failure of the low bidder to furnish affidavit and/or documentation as required by G.S. 143-128.2(c) shall constitute a basis for disqualification of the bid.

Should the owner adjudge that the apparent low bidder is not the lowest responsible, responsive bidder by virtue of the above information, said apparent low bidder will be so notified and his bid security shall be returned to him.

8. PERFORMANCE BOND

The successful bidder, upon award of contract, shall furnish a performance bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

9. PAYMENT BOND

The successful bidder, upon award of contract, shall furnish a payment bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

10. PAYMENTS

Payments to the successful bidders (contractors) will be made on the basis of monthly estimates. See Article 31, General Conditions.

11. PRE-BID CONFERENCE

Prior to the date set for receiving bids, the Designer may arrange and conduct a Pre-Bid Conference for all prospective bidders. The purpose of this conference is to review project requirements and to respond to questions from prospective bidders and their subcontractors or material suppliers related to the intent of bid documents. Attendance by prospective bidders shall be as required by the "Notice to Bidders".

12. SUBSTITUTIONS

In accordance with the provisions of G.S. 133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until ten (10) days prior to the receipt of bids when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

Submittals for proposed substitutions shall include the following information:

- a. Name, address, and telephone number of manufacturer and supplier as appropriate.
- b. Trade name, model or catalog designation.
- c. Product data including performance and test data, reference standards, and technical descriptions of material, product, or equipment. Include color samples and samples of available finishes as appropriate.
- d. Detailed comparison with specified products including performance capabilities, warranties, and test results.
- e. Other pertinent data including data requested by the Designer to confirm product equality.

If a proposed material, product, or equipment substitution is deemed equal by the Designer to those specified, all bidders of record will be notified by Addendum.

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 Notice to Bidders; Instructions to Bidders; 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 proposal; 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 through the agency named in the contract.
- c. The **designer(s)** are those referred to within this contract, or their authorized representatives. The Designer(s), as referred to herein, shall mean architect and/or engineer. They will be referred to hereinafter as if each were of the singular number, masculine gender.
- d. The **contractor**, as referred to hereinafter, shall be deemed to be either of the several contracting parties called the "Party of the First Part" in either of the several contracts in connection with the total project. Where, in special instances hereinafter, a particular contractor is intended, an adjective precedes the word "contractor," as "general," "heating," etc. For the purposes of a single prime contract, the term Contractor shall be deemed to be the single contracting entity identified as the "Party of the First Part" in the single Construction Contract. Any references or adjectives that name or infer multiple prime contractors shall be interpreted to mean the single prime Contractor.
- e. A **subcontractor**, as the term is used herein, shall be understood to be one who has entered into a direct contract with a contractor, 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.
- h. The **project** is the total construction work to be performed under the contract documents by the several contractors.
- i. **Project Expediter**, as used herein, is an entity stated in the contract documents, designated to effectively facilitate scheduling and coordination of work activities. See Article 14(f) for responsibilities of a Project Expediter. **For the purposes of a single prime contract, the single prime contractor shall be designated as the Project Expediter.**
- j. **Change order**, as used herein, shall mean a written order to the contractor subsequent to the signing of the contract authorizing a change in the contract. The change order shall be signed by the contractor, 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 contractor to proceed with the work requested by owner prior to issuance of a formal Change Order. The field order shall be signed by the contractor, designer, owner, and State Construction Office.
- l. **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).
- m. **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 contractor(s) 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 contractor, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused solely by the Contractor (e.g., if a multi-phased project-subsequent phases, delays in start other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).
- n. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the contractor, and which engages to be responsible for the contractor and his acceptable performance of the work.
- o. **Routine written communications between the Designer and the Contractor** 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 can not be identified as "request for information".
- p. **Clarification or Request for information (RFI)** is a request from the Contractor 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 Contractor's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.
- q. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work.
- r. **Inspection** shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.
- s. **"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 Designer and owner.
- t. **"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.

- u. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.
- v. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.
- w. **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.
- x. **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.
- y. **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.
- z. **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.
- aa. **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.
- bb. 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, and 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 bid for 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 contractor shall execute each copy of the proposal, 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 contractor'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 contractor's signature on the performance bond and the payment bond shall correspond with that on the contract. The date of performance and payment bond shall not be prior to the date of 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 contractor(s) 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 contractor 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 contractors electronic copies of plans and specifications. If requested by the contractor, paper copies of plans and specifications shall be furnished free of charge as follows:

- a. General contractor - Up to twelve (12) sets of general contractor drawings and specifications, up to six (6) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

- b. Each other contractor - Up to six (6) sets of the appropriate drawings and specifications, up to three (3) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.
- c. Additional sets shall be furnished at cost, including mailing, to the contractor upon request by the contractor. This cost shall be stated in the bidding documents.
- d. For the purposes of a single-prime contract, the contractor shall receive up to 30 sets of drawings and specifications, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

- a. Within 15 consecutive calendar days after the notice to proceed, each prime contractor shall submit a schedule for submission of all shop drawings, product data, samples, and similar submittals through the Project Expediter 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 Contractor(s) 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 Contractor'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 Contractor. 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 or of separate Contractors.
- 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 Contractor not later than twenty (20) days from the date of receipt by the Designer, for the Contractor'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/submittals by the Designer shall not be construed as relieving the Contractor 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 lack of compliance or errors first have been called in writing to the attention of the Designer by the Contractor.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

- a. The contractor 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, his authorized representative, owner or State Construction Office.

- b. The contractor 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 contractor and submitted to the designer upon project completion and no later than 30 days after final 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 contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, heat, sanitary facilities, water, scaffolding and incidentals necessary for the completion of his work, and shall 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, and 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 therefrom, 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 contractor shall furnish evidence 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 Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the 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. Request for substitution of materials, items, or equipment shall be submitted to the 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 the award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and owner approves.
- e. 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 language, conduct, or attire 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 contractor 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 contractor shall protect and save harmless the owner against suit on account of alleged or actual infringement. The contractor 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 contractor 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 contractor observes that the drawings and specifications are at variance therewith, he shall promptly notify the designer in writing. See Instructions to Bidders, Paragraph 3, Bulletins and Addenda. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the contractor performs any work 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 therefrom. 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 contractor and included within the bid proposal. All water taps, meter barrels, vaults and impact fees shall be paid by the contractor unless otherwise noted.
- d. 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 contractor shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.
- e. Projects involving local funding (community colleges) are subject also to county and municipal building codes and inspection by local authorities. The contractor shall pay the cost of these permits and inspections.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

- a. The contractors shall be jointly 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. They 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. They shall be responsible for and pay for any damages caused to the owner. All contractors shall have access to the project at all times.
- b. The contractor shall provide 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, whether set by him, or any of the subcontractors. 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 and owner.
- d. The contractor shall protect all trees and shrubs designated to remain in the vicinity of the operations by building substantial boxes around same. He shall barricade all walks, roads, etc., 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 contractor shall provide 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. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.
- f. The contractor 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 General Statutes of North Carolina 95-126 through 155.
- g. The contractor 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 emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the contractor 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 contractor 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 contractor(s) 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 contractor(s) 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 contractor(s) 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 contractor(s) 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 and during any time work is in preparation and progress 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 contractor shall therefore provide safe access to the work at all times for such inspections.
- b. All instructions to the contractor 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 contractor.
- c. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. Contractor shall give a minimum two weeks notice unless otherwise agreed to by all parties. If inspection fails, after the first reinspection all costs associated with additional reinspections shall be borne by the contractor.

- d. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the contractor shall give adequate notice to the designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the designer. Such special tests or inspections will be made in the presence of the designer, or his authorized representative, and it shall be the contractor's responsibility to serve ample notice of such tests.
- e. All laboratory tests shall be paid by the owner unless provided otherwise in the contract documents except the general contractor 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.
- f. Should any work be covered up or concealed prior to inspection and approval by the designer, special inspector, and/or State Construction Office such work shall be uncovered or exposed for inspection, if so requested by the designer in writing. Inspection of the work will be made upon notice from the contractor. 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 contractor involved.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

- a. Throughout the progress of the work, each contractor shall keep at the job site, a competent superintendent and supervisory staff satisfactory to the designer and the owner. The superintendent and supervisory staff shall not be changed without the consent of the designer and owner unless said superintendent ceases to be employed by the contractor or ceases to be competent as determined by the contractor, designer or owner. The superintendent and other staff designated by the contractor in writing shall have authority to act on behalf of the contractor, and instructions, directions or notices given to him shall be as binding as if given to the contractor. However, directions, instructions, and notices shall be confirmed in writing.
- b. The contractor 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. All contractors shall be required to cooperate and consult with each other during the construction of this project. Prior to installation of work, all contractors shall jointly prepare coordination drawings, showing locations of various ductworks, piping, motors, pumps, and other mechanical or electrical equipment, in relation to the structure, walls and ceilings. These drawings shall be submitted to the designer through the Project Expediter for information only. Each contractor shall lay out and execute his work to cause the least delay to other contractors. Each contractor shall be financially responsible for any damage to other contractor's work and for undue delay caused to other contractors on the project.
- d. The contractor is required to attend job site progress conferences as called by the designer. The contractor shall be represented at these job progress conferences by both home office and project personnel. These representatives shall have authority to act on behalf of the contractor. These meetings shall be open to subcontractors, material

suppliers and any others 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. Each contractor shall be prepared to assess progress of the work as required in his particular contract and to recommend remedial measures for correction of progress as may be appropriate. The designer or his authorized representative shall be the coordinator of the conferences and shall preside as chairman. The contractor 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.

- e. The contractor(s) 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 in a location where same will not be disturbed and where direct instruments sights may be taken.
- f. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be designated in the Supplementary General Conditions. The Project Expediter shall have at a minimum the following responsibilities.
 - 1. Prepare the project construction schedule and shall allow all prime contractors (multi-prime contract) and subcontractors (single-prime contract) performing general, plumbing, HVAC, and electrical work equal input into the preparation of the initial construction schedule.
 - 2. Maintain a project progress schedule for all contractors.
 - 3. Give adequate notice to all contractors to ensure efficient continuity of all phases of the work.
 - 4. Notify the designer of any changes in the project schedule.
 - 5. Recommend to the owner whether payment to a contractor shall be approved.
- g. It shall be the responsibility of the Project Expediter to cooperate with and obtain from several prime contractors and subcontractors on the job, their respective work activities and integrate these activities into a project construction schedule in form of a detailed bar chart or Critical Path Method (CPM), schedule. Each prime contractor shall provide work activities within fourteen (14) days of request by the Project Expediter. A “work activity”, for scheduling purposes, shall be any component or contractual requirement of the project requiring at least one (1) day, but not more than fourteen (14) days, to complete or fulfill. The project construction schedule shall graphically show all salient features of the work required to construct the project from start to finish and within the allotted time established in the contract. The time (in days) between the contractor’s early completion and contractual completion dates is part of the project total float time; and shall be used as such, unless amended by a change order. On a multi-prime project, each prime contractor shall review the proposed construction schedule and approve same in writing. The Project Expediter shall submit the proposed construction schedule to the designer for comments. The complete Project construction schedule shall be of the type set forth in the Supplementary General Condition or subparagraph (1) or (2) below, as appropriate:

1. For a project with total contracts of \$500,000 or less, a bar chart schedule will satisfy the above requirement. The schedule shall indicate the estimated starting and completion dates for each major element of the work.
2. For a project with total contracts over \$500,000, a Critical Path Method (CPM) schedule shall be utilized to control the planning and scheduling of the Work. The CPM schedule shall be the responsibility of the Project Expediter and shall be paid for by the Project Expediter.

Bar Chart Schedule: Where a bar chart schedule is required, it shall be time-scaled in weekly increments, shall indicate the estimated starting and completion dates for each major element of the work by trade and by area, level, or zone, and shall schedule dates for all salient features, including but not limited to the placing of orders for materials, submission of shop drawings and other Submittals for approval, approval of shop drawings by designers, the manufacture and delivery of material, the testing and the installation of materials, supplies and equipment, and all Work activities to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s). Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

CPM Schedule: Where a CPM schedule is required, it shall be in time-scaled precedence format using the Project Expediter's logic and time estimates. The CPM schedule shall be drawn or plotted with activities grouped or zoned by Work area or subcontract as opposed to a random (or scattered) format. The CPM schedule shall be time-scaled on a weekly basis and shall be drawn or plotted at a level of detail and logic which will schedule all salient features of the work to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s).. Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

The CPM schedule will identify and describe each activity, state the duration of each activity, the calendar dates for the early and late start and the early and late finish of each activity, and clearly highlight all activities on the critical path. "Total float" and "free float" shall be indicated for all activities. Float time shall not be considered for the exclusive use or benefit of either the Owner or the Contractor, but must be allocated in the best interest of completing the Work within the Contract time. Extensions to the Contract time, when granted by Change Order, will be granted only when equitable time adjustment exceeds the Total Float in the activity or path of activities affected by the change. On contracts with a price over \$2,500,000, the CPM schedule shall also show what part of the Contract Price is attributable to each activity on the schedule, the sum of which for all activities shall equal the total Contract Price.

Early Completion of Project: The Contractor may attempt to complete the project prior to the Contract Completion Date. However, such planned early completion shall be for the Contractor's convenience only and shall not create any additional rights of the Contractor or obligations of the Owner under this Contract, nor shall it change the Time

for Completion or the Contract Completion Date. The Contractor shall not be required to pay liquidated damages to the Owner because of its failure to complete by its planned earlier date. Likewise, the Owner shall not pay the Contractor any additional compensation for early completion nor will the Owner owe the Contractor any compensation should the Owner, its officers, employees, or agents cause the Contractor not to complete earlier than the date required by the Contract Documents.

- h. The proposed project construction schedule shall be presented to the designer no later than fifteen (15) days after written notice to proceed. No application for payment will be processed until this schedule is accepted by the designer and owner.
- i. The approved project construction schedule shall be distributed to all contractors and displayed at the job site by the Project Expediter.
- j. The several contractors shall be responsible for their work activities and shall notify the Project Expediter of any necessary changes or adjustments to their work. The Project Expediter shall maintain the project construction schedule, making biweekly adjustments, updates, corrections, etc., that are necessary to finish the project within the Contract time, keeping all contractors and the designer fully informed. Copy of a bar chart schedule annotated to show the current progress shall be submitted by the Contractor(s) to the designer, along with monthly request for payment. For project requiring CPM schedule, the Contractor shall submit a biweekly report of the status of all activities. The bar chart schedule or status report shall show the actual Work completed to date in comparison with the original Work scheduled for all activities. If any activities of the work of several contractors are behind schedule, the contractor must indicate in writing, what measures will be taken to bring each such activity back on schedule and to ensure that the Contract Completion Date is not exceeded. A plan of action and recovery schedule shall be developed and submitted to the designer by the Project Expediter, when (1) the contractor's report indicates delays, that are in the opinion of the designer or the owner, of sufficient magnitude that the contractor's ability to complete the work by the scheduled completion is brought into question; (2) the updated construction schedule is thirty (30) days behind the planned or baseline schedule and no legitimate time extensions, as determined by the Designer, are in process; and (3) the contractor desires to make changes in the logic (sequencing of work) or the planned duration of future activities of the CPM schedule which, in the opinion of the designer or the owner, are of a major nature. The plan of action, when required shall be submitted to the Owner for review within two (2) business days of the Contractor receiving the Owner's written demand. The recovery schedule, when required, shall be submitted to the Owner within five (5) calendar days of the Contractor's receiving the Owner's written demand. Failure to provide an updated construction schedule or a recovery schedule may be grounds for rejection of payment applications or withholding of funds as set forth in Article 33.
- k. The Project Expediter shall notify each contractor of such events or time frames that are critical to the progress of the job. Such notice shall be timely and reasonable. Should the progress be delayed due to the work of any of the several contractors, it shall be the duty of the Project Expediter to immediately notify the contractor(s) responsible for such delay, the designer, the State Construction Office and other prime contractors. The designer shall determine the contractor(s) who caused the delays and notify the bonding company of the responsible contractor(s) of the delays; and shall make a recommendation to the owner regarding further action.
- l. Designation as Project Expediter entails an additional project control responsibility and does not alter in any way the responsibility of the contractor so designated, nor the

responsibility of the other contractors involved in the project. The project expeditor's Superintendent(s) shall be in attendance at the Project site at all times when work is in progress unless conditions are beyond the control of the Contractor or until termination of the Contract in accordance with the Contract Documents. It is understood that such Superintendent shall be acceptable to the Owner and Designer and shall be the one who will be continued in that capacity for the duration of the project unless he ceases to be on the Contractor's payroll or the Owner otherwise agrees. The Superintendent shall not be employed on any other project for or by the Contractor or by any other entity during the course of the Work. If the Superintendent is employed by the Contractor on another project without the Owner's approval, then the Owner may deduct from the Contractor's monthly general condition costs and amount representing the Superintendent's cost and shall deduct that amount for each month thereafter until the Contractor has the Superintendent back on the Owner's Project full-time.

ARTICLE 15 - SEPARATE CONTRACTS AND CONTRACTOR RELATIONSHIPS

- a. Effective from January 1, 2002, Chapter 143, Article 8, was amended, to allow public contracts to be delivered by the following delivery methods: single-prime, dual (single-prime and separate-prime), construction manager at risk, and alternative contracting method as approved by the State Building Commission. The owner reserves the right to prepare separate specifications, receive separate bids, and award separate contracts for such other major items of work as may be in the best interest of the State. For the purposes of a single prime contract, refer to Article 1 – Definitions.
- b. All contractors shall cooperate with each other in the execution of their work, and shall plan their work in such manner as to avoid conflicting schedules or delay of the work. See Article 14, Construction Supervision.
- c. If any part of contractor's work depends upon the work of another contractor, defects which may affect that work shall be reported to the designer in order that prompt inspection may be made and the defects corrected. Commencement of work by a contractor where such condition exists will constitute acceptance of the other contractor's work as being satisfactory in all respects to receive the work commenced, except as to defects which may later develop. The designer shall be the judge as to the quality of work and shall settle all disputes on the matter between contractors.
- d. Any mechanical or electrical work such as sleeves, inserts, chases, openings, penetrations, etc., which is located in the work of the general contractor shall be built in by the general contractor. The respective mechanical and electrical contractors shall set all sleeves, inserts and other devices that are to be incorporated into the structure in cooperation and under the supervision of the general contractor. The responsibility for the exact location of such items shall be that of the mechanical and/or electrical contractor.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress and during normal working hours. The contractor shall provide facilities for such access so the designer may perform his functions under the contract documents.
- f. Should a contractor cause damage to the work or property of another contractor, he shall be directly responsible, and upon notice, shall promptly settle the claim or otherwise resolve the dispute.

ARTICLE 16 - SUBCONTRACTS AND SUBCONTRACTORS

- a. Within thirty (30) days after award of the contract, the contractor shall submit to the designer, owner and to the State Construction Office a list giving the names and addresses of subcontractors and equipment and material suppliers he proposes to use, together with the scope of their respective parts of the work. Should any subcontractor be disapproved by the designer or owner, the designer or owner shall submit his reasons for disapproval in writing to the State Construction Office for its consideration with a copy to the contractor. If the State Construction Office concurs with the designer's or owner's recommendation, the contractor shall submit a substitute for approval. The designer and owner shall act promptly in the approval of subcontractors, and when approval of the list is given, no changes of subcontractors will be permitted except for cause or reason considered justifiable by the designer or owner.
- b. The designer will furnish to any subcontractor, upon request, evidence regarding amounts of money paid to the contractor on account of the subcontractor's work.
- c. The contractor is and remains fully responsible for his own acts or omissions as well as those of any subcontractor or of any employee of either. The contractor agrees that no contractual relationship exists between the subcontractor and the owner in regard to the contract, and that the subcontractor acts on this work as an agent or employee of the contractor.
- d. The owner reserves the right to limit the amount of portions of work to be subcontracted as hereinafter specified.

ARTICLE 17 - CONTRACTOR AND SUBCONTRACTOR RELATIONSHIPS

The contractor agrees that the terms of these contract documents shall apply equally to each subcontractor as to the contractor, and the contractor agrees to take such action as may be necessary to bind each subcontractor to these terms. The contractor further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to contractor-subcontractor relationships, and that payments to subcontractors shall be made in accordance with the provisions of 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 G.S. 136-28.1, the balance due prime contractors 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 contractor, 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. No payment shall be delayed because of the failure of another prime contractor on such project to complete his contract. Should final payment to any prime contractor beyond the date such contracts have been certified to be completed by the designer or architect, 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 prime contractor 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 a prime contractor during construction shall be paid in accordance with the payment provisions of the contract documents or said prime contractor 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 prime contractor of each periodic or final payment, the prime contractor shall pay the subcontractor based on work completed or service provided under the subcontract. Should any periodic or final payment to the subcontractor be delayed by more than seven days after receipt of periodic or final payment by the prime contractor, the prime contractor shall pay the subcontractor 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 prime contractor to the subcontractor shall not exceed the percentage of retainage on payments made by the owner to the prime contractor. Any percentage of retainage on payments made by the prime contractor to the subcontractor that exceeds the percentage of retainage on payments made by the owner to the prime contractor shall be subject to interest to be paid by the prime contractor to the subcontractor at the rate of one percent (1%) per month or fraction thereof.
- d. Nothing in this section shall prevent the prime contractor at the time of application and certification to the owner from withholding application and certification to the owner for payment to the subcontractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of subcontractor to make timely payments for labor, equipment and materials; damage to prime contractor or another subcontractor; reasonable evidence that subcontract 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 designer shall provide general administration of the performance of construction contracts, including 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 direct work to be performed, to stop work, to order work removed, or to order corrections of faulty work, where any such action by the designer may be necessary to assure successful completion of the work.
- b. The 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 contractor, taking sides with neither.
- c. Should the 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 designer.

- d. The designer and his consultants will make inspections of the project. He will inspect the progress, the quality and the quantity of the work.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress during normal working hours. The contractor shall provide facilities for such access so the designer and owner may perform their functions under the contract documents.
- f. Based on the designer's inspections and evaluations of the project, the designer shall issue interpretations, directives and decisions as may be necessary to administer the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract.

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 contractor 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, electronically, 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.

In the event of emergency endangering life or property, the contractor may be directed to proceed on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the designer or owner, 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, 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, or subsequently agreed to by the Contractor, Designer, Owner and State Construction Office 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 shall be as follows: all contractors (the single contracting entity (prime), his subcontractors(1st tier subs), or their sub-subcontractors (2nd tier subs, 3rd tier subs, etc)) shall be allowed a maximum of 10% on work they each self-perform; the prime contractor shall be allowed a maximum of 5% on contracted work of his 1st tier sub; 1st tier, 2nd tier, 3rd tier, etc contractors shall be allowed a maximum of 2.5% on the contracted work of their subs. ; 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 work;
 2. The actual costs of labor expended on the project site; labor expended in coordination, change order negotiation, record document maintenance, shop drawing revision or other tasks necessary to the administration of the project are considered overhead whether they take place in an office or 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 work;
 5. The actual costs of premiums for bonds, insurance, permit fees, and sales or use taxes related to the work.

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 unit cost breakdown showing method of arriving at net cost as defined above.
- g. In all change orders, the procedure will be for the designer to request proposals for the change order work in writing. The contractor will provide such proposal and supporting data in suitable format. The designer shall verify correctness. Delay in the processing of the change order due to lack of proper submittal by the contractor of all required supporting data shall not constitute grounds for a time extension or basis of a claim. Within fourteen (14) days after receipt of the contractor's accepted proposal including all supporting documentation required by the designer, the designer shall prepare the change order and forward to the contractor for his signature or otherwise respond, in writing, to

the contractor's proposal. Within seven (7) days after receipt of the change order executed by the contractor, the 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. 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 contractor 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 contractor's terms are unacceptable, the owner, with the approval of the State Construction Office, may require the contractor to perform such work on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the Designer or owner, a correct account of cost together with all proper invoices, payrolls and supporting data. Upon completion of the work a change order will be prepared with allowances for overhead and profit per paragraph d. above and "net cost" and "cost" per paragraph e. 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 contractor consider that as a result of instructions given 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 contractor 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 shall 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 contractor shall not act on instructions received by him from persons other than the designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The designer shall not be responsible for misunderstandings claimed by the contractor 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 contractor and is denied by the designer or owner, and cannot be resolved by a

representative of the State Construction Office, the contractor may request a mediation in connection with GS 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 contractor is unable to resolve its claim as a result of mediation, the contractor may pursue the claim in accordance with the provisions of G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner, and the following:

1. A contractor who has not completed a contract with a board 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 contractor 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 Chapter 150B of the General Statutes.
2. (a) A contractor who has completed a contract with a board 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 contractor claims is due. The claim shall be submitted within sixty (60) days after the contractor 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 contractor agree. The contractor 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 contractor a written statement of the director's decision on the contractor's claim.
 - (c) A contractor 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 contractor 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 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 contractor.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the owner and the designer, the owner shall be reimbursed by the contractor. 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 time of completion is stated in the Supplementary General Conditions and in the Form of Construction Contract. The Project Expediter, upon notice of award of contract, shall prepare a construction schedule to complete the project within the time of completion as required by Article 14.
- b. The contractors shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the designer and shall fully complete all work hereunder within the time of completion stated. Time is of the essence and the contractor acknowledges the Owner will likely suffer financial damage for failure to complete the work within the time of completion. For each day in excess of the above number of days, the contractor(s) 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 said contractor(s) to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof.
- c. In the event of multiple prime contractors, the designer shall be the judge as to the division of responsibility between the contractor(s), based on the construction schedule, weekly reports and job records, and shall apportion the amount of liquidated damages to be paid by each of them, according to delay caused by any or all of them.
- d. If the contractor is delayed at any time in the progress of his work solely by any act or negligence of the owner, the designer, or by any employee of either; by any separate contractor employed by the owner; 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 only 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 contractor 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.

- e. 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 Contractor shall notify the Designer to the designer, copies to the owner and SCO, of the delay within 20 days of the beginning of the delay and only one claim is necessary.
- f. The contractor shall notify his surety in writing of extension of time granted.
- g. No claim for time extension shall be allowed on account of failure of the 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 prior to the completion of the project.
- 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.
 - 2. Contractor will obtain consent of surety.
 - 3. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.
- c. The owner shall have the right to exclude the contractor from any part of the project which the designer has so certified to be substantially complete, but the owner will allow the contractor 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 contractor 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 contractor(s) that the project is complete and ready for inspection, the 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 contractor(s) shall complete all items requiring corrective measures noted at the Designer

final inspection. The designer shall schedule a SCO final inspection at a time and date acceptable to the owner, contractor(s) and 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 one of the following determinations:
 - 1. That the project is completed and accepted.
 - 2. That the project will be 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.
 - 4. That the project is not complete and another date for a SCO final inspection will be established.
- c. Within fourteen (14) days of final acceptance per Paragraph b1 or within fourteen (14) days after completion of punch list per Paragraph b2 above, the 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 b1 or b2 above shall be handled in accordance with Article 42, Guarantee.
- f. The final acceptance date will establish the following:
 - 1. The beginning of guarantees and warranties period.
 - 2. The date on which the contractor'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 contractor.
- g. **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 contractor, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the owner. Work or property of other contractors or the owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the contractor whose work is faulty.

- b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the designer, and shall make satisfactory progress, as determined by the designer, until completed.
- c. Should the contractor 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 designer, shall relieve the contractor from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. Contractor shall correct or make good any defects due thereto and repair any damage resulting there from, 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 contractor and establish a time limit for completion of corrections by the contractor. 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 contractor 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 contractor 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 contractor, such action and cost of same having been first approved by the designer. Should the cost of such action of the owner exceed the amount due or to become due the contractor, then the contractor 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 contractor fails to begin the work under the contract within the time specified, 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 contractor 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 contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor 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 contractor, 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 contractor 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 contractor, then the said contractor 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 contractor and the surety shall be liable and shall pay to the owner the amount of said excess.

ARTICLE 30 - CONTRACTOR'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 contractor, 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 contractor, 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 contractor for the cost of all materials delivered and work performed on this contract plus 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 contractor 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 contractor 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 contractor'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. The contractor, upon request of the designer, shall substantiate the request with invoices of vouchers or payrolls or other evidence.
- c. Prior to submitting the first request, the contractor shall prepare for the designer a schedule showing a breakdown of the contract price into values of the various parts of the work, so arranged as to facilitate payments to subcontractors in accordance with Article 17, Contractor and Subcontractor Relationships. The contractor(s) shall list the

value of each subcontractor and supplier, identifying each minority business subcontractor and supplier as listed in Affidavit C, if applicable.

- d. 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 contractor 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 contractor, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the contractor 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 contractor'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 contractor. 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 contractor(s).
- e. In the event of beneficial occupancy, retainage of funds due the contractor(s) 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 contractor's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

- a. Within five (5) days from receipt of request for payment from the contractor, 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 contractor 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 contractor.
 - 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 contractor 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 contractor 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 contractor 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 contract amounts and total actual payments to subs and material suppliers.
 2. Affidavit of Release of Liens.
 3. Affidavit of contractors 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 designer, certificates of compliance issued, and the contractor has complied with the closeout requirements. The designer shall forward the contractor’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.
- b. The secretary of the Department of Administration may authorize the withholding of payment for the following reasons:
 1. Claims filed against the contractor or evidence that a claim will be filed.
 2. Evidence that subcontractors have not been paid.
 - c. The Owner may withhold all or a portion of Contractor's general conditions costs set forth in the approved schedule of values, if Contractor 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 contractor without cause will make owner liable for payment of interest to the contractor 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 contractor has obtained all required insurance and verifying certificates of insurance have been approved in writing by the owner. These certificates shall document that coverages afforded under the policies will not be cancelled, reduced in amount or coverages 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. If endorsements are needed to comply with the notification or other requirements of this article copies of the endorsements shall be submitted with the certificates.

a. Worker's Compensation and Employer's Liability

The contractor shall provide and maintain, until final acceptance, 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 contractor shall provide and maintain, until final acceptance, 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 contractor shall purchase and maintain property insurance until final acceptance, upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the owner, the contractor, the subcontractors and sub-subcontractors in the work and shall insure against the perils of fire, wind, rain, flood, extended coverage, and vandalism and malicious mischief. If the owner is damaged by failure of the contractor to purchase or maintain such insurance, then the contractor shall bear all reasonable costs properly attributable thereto; the contractor 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 contractor.

e. Other Insurance

The contractor 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 contractor 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. Each contractor 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. Bonds shall be executed in the form bound with these 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 contractor on account of the contract shall not become due until the contractor 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 in connection with his contract have been satisfied, and that no claims or

liens exist against the contractor in connection with this contract. In the event that the contractor cannot obtain similar affidavits from subcontractors to protect the contractor and the owner from possible liens or claims against the subcontractor, the contractor shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the contractor's) knowledge, and if any appear afterward, the contractor shall save the owner harmless.

ARTICLE 37 - ASSIGNMENTS

The contractor 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 contractor under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

- a. The contractor(s) 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 owner and shall not exceed those established limits in his operations.
- b. The contractor(s) shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.
- c. The contractor(s) 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 contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts 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 contractor shall endanger any work of another contractor by cutting, digging or other means. No contractor shall cut or alter the work of any other contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

- a. The contractor shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer and other utility services which maybe necessary and required for completion of the project including all utilities required for testing, cleaning, balancing, and sterilization of designated plumbing, mechanical and electrical systems. Any permanent meters installed shall be listed in the contractor's name until work has a final acceptance. The contractor will be solely responsible for all utility costs prior to final acceptance. Contractor shall contact all affected utility companies prior to bid to determine their requirements to provide temporary and permanent service and include all costs associated with providing those services in their bid. Coordination of the work of the utility companies during construction is the sole responsibility of the contractor.

- b. Meters shall be relisted in the owner's name on the day following final acceptance of the Project Expediter's work, and the owner shall pay for services used after that date.
- c. The owner shall be reimbursed for all metered utility charges after the meter is relisted in the owner's name and prior to completion and acceptance of the work of **all** contractors. Reimbursement shall be made by the contractor whose work has not been completed and accepted. If the work of two or more contractors has not been completed and accepted, reimbursement to the owner shall be paid by the contractors involved on the basis of assessments by the designer.
- d. Prior to the operation of permanent systems, the Project Expediter will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.
- e. All contractors shall have the permanent building systems 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 contractor(s), the designer and owner. Use of the equipment in this manner shall be subject to the approval of the Designer and owner and shall in no way affect the warranty requirements of the contractor(s).
- f. The electrical contractor shall have the building's permanent power wiring distribution system in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.
- g. The electrical contractor shall have the building's permanent lighting system ready at the time the general contractor begins interior painting and shall provide adequate lighting in those areas where interior painting and finishing is being performed.
- h. Each prime contractor 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 final acceptance of work by the State Construction Office, each contractor shall remove and replace 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 electrical contractor shall have all lamps in proper working condition at the time of final project acceptance.
 - i. The Project Expediter 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.
 - j. The Project Expediter 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.
 - k. On multi-story construction projects, the Project Expediter shall provide temporary elevators, lifts, or other special equipment for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall be included in the Project Expediter's bid.
 - l. The Project Expediter 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 names of prime contractors on the project, 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 contractors shall keep the building and surrounding area 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 or Project Expediter. The Project Expediter shall provide an on site refuse container(s) for the use of all contractors. Each contractor shall remove their rubbish and debris from the building on a daily basis. The Project Expediter shall broom clean the building as required to minimize dust and dirt accumulation.
- b. The Project Expediter shall provide and maintain suitable all-weather access to the building.
- c. Before final inspection and acceptance of the building, each contractor shall clean his portion of the work, 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 contractor 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 contractor 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 contractor 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 contractor 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 there from, and (2) is caused in whole or in part by any negligent act or omission of the contractor, the contractor's subcontractor, or the agents of either the contractor or the contractor'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 and contract sum.
- e. **Accounting Procedures for Refund of County Sales & Use Tax**

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

Contractors performing contracts for state agencies shall give the state agency for whose project the property was purchased a signed statement containing the information listed in 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 as of April 1, 1991 from the contractor 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 contractor.

Similar certified statements by his subcontractors must be obtained by the general contractor and furnished to the claimant.

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 contractor(s) agree not to discriminate against any employee or applicant for employment because of physical or mental disabilities in regard to any position for which the employee or applicant is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified individuals with such disabilities without discrimination based upon their physical or mental disability 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.

Contractors are reminded of the requirements of instructions under Instructions to Bidders and 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

GS 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix E are hereby incorporated into and made a part of this contract.

ARTICLE 50 – CONTRACTOR EVALUATION

The contractor'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 bid on future State capital improvement projects. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, Contractor Evaluation Procedures, is hereby incorporated and made a part of this contract. The owner may request the contractor'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 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, 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

Owner may at any time and for any reason terminate Contractor's services and work at Owner's convenience. Upon receipt of such notice, Contractor 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.

Upon such termination, Contractor 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 Contractor 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 Contractor prior to the date of the termination of this Agreement. Contractor 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
(SGC's) OF THE CONTRACT**

**STANDARD FORM FOR CONSTRUCTION
CONTRACTS**

**NORTH CAROLINA STATE
UNIVERSITY**

NC State University Design and Construction Guidelines

Supplementary General Conditions

SUPPLEMENTARY GENERAL CONDITIONS (SGC's) OF THE CONTRACT

The use or reproduction of this document or any part thereof is authorized for and limited to use on projects of North Carolina State University, and is distributed by, through and at the discretion of the University for that distinct and sole purpose. This document supplements but does not alter in any way the requirements of the General Conditions of the Contract.

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1.0 SGC Article 1 – Definitions

- A. As defined in Article 1 of the General Conditions, the Supplementary General Conditions are considered part of the contract documents.
- B. The Owner is the State of North Carolina through North Carolina State University.
- C. Provide shall mean purchase, deliver, and install, new, clean, and completely operational, fully tested and ready for use.

2.0 SGC Article 14 – Construction Supervision and Schedule

- A. The contractor(s) shall employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a benchmark nearby in a location where same will not be disturbed and where direct instruments sights may be taken.
- B. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be the General Contractor unless determined otherwise by the designer. The Project Expediter shall have the responsibilities described in Article 14.f. of the General Conditions.
- C. Project Construction Schedule. North Carolina State University requires a CPM schedule for all projects, regardless of size and/or dollar amount. Bar Chart schedules may be allowed on a case-by-case basis. All CPM schedules shall meet the requirements of the General Conditions as well as the following:
 - 1. The CPM Baseline Schedule or Updated Schedule shall consist of the computer files on electronic media necessary to recreate the schedule. Files shall consist of four discrete items:
 - a) The Activity description including the original and remaining durations, and percent complete. Show other computed information such as early and late computed start and finish times and various types of floats.
 - b) The logical predecessor and successor relationships that connect the various activities together to form a CPM network. All activities shall be linked with no

NC State University Design and Construction Guidelines

Supplementary General Conditions

constraints placed on any activity unless critical milestone dates are dictated in the contract.

- c) Constraints listing if any must exist.
 - d) All hidden codes or constraints assigned to activities by the Scheduler, which help define the intended workflow or project organization.
2. Each schedule submittal shall include a cover letter, a narrative, a hard copy of the schedule and the schedule files on electronic media. The schedule update narrative should state what activity changes happened on the project, including missing data, upcoming changes, documented delays, potential delays and other facts.
 3. Contractors and subcontractors shall include a minimum of five (5) full days in their base bid for their project superintendent and project manager to attend a preliminary scheduling meeting with the project expediter. Each contractor shall attend additional scheduling meetings as required until an acceptable construction schedule conforming to the contract time is completed and approved via signing of the printed schedule by the single or each prime contractor (project manager and superintendent). Copies of the signed schedule shall be given to the Designer, Owner and each signatory; the original shall be displayed at the jobsite. The submitted schedule shall show the contract project completion date.
 4. The schedule shall be updated monthly or at the Designer and/or Owner's request. The project expediter shall make all updates, adjustments, corrections, etc., with input provided from the other prime or subcontractors. It will be the responsibility of each prime and/or subcontractor to either agree or disagree with the updated schedule via signing and dating the schedule submitted by the project expediter or providing a written summary of schedule exceptions and/or inaccuracies.
 5. Project expediter is required to provide an updated construction schedule with each monthly payment application. It will be the responsibility of each prime and/or subcontractor to either agree or disagree with the updated schedule via signing and dating the schedule submitted by the project expediter or providing a written summary of schedule exceptions and/or inaccuracies. Payment requests received without one or the other of the above will be considered incomplete and will be returned as being incomplete. The only contractor required to submit a copy of the updated progress schedule with his monthly payment application is the project expediter.
 6. A completion or finish schedule is required at 80% project completion, illustrating tasks remaining to complete the project. The designer and Owner are required to approve finish schedule.
 7. Project expediter shall include all relevant testing and inspections on the CPM schedule, including but not limited to: telecom/data wiring tests and as-built drawings, fire alarm system testing, fire suppression system testing, piping pressure testing, all applicable NFPA, DOI, DOL tests and commissioning activities.
 8. The Contractor will schedule as Milestones in the CPM schedule and ensure they are met the following activities: MEPFP Coordination drawings, Casework and Fume Hood Submittals and shop drawings shall be submitted to the design team for review NO LATER than 30 days after the Notice To Proceed.

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3.0 SGC Article 23 - Time Of Completion, Delays, Extension of Time

A. For each day in excess of the number of days shown below, the contractor(s) shall pay the owner liquidated damages in the amount of \$_____ per consecutive calendar day. [Designer and Owner to jointly determine amount of LD's based on specific project requirements.]

This project does not include Commissioning

B. The time of completion for this project is _____ consecutive calendar days and begins on the date stated in the Designer's Notice to Proceed letter issued to the contractor.

This project includes Commissioning

B. The time of completion to SUBSTANTIAL COMPLETION for this project is _____ consecutive calendar days and begins on the date stated in the Designer's Notice to Proceed letter issued to the contractor. SUBSTANTIAL COMPLETION for this project is defined as the General Contractor and its subcontractors having completed the following:

1. GC's Pre-Final Punch List
2. Testing Adjusting and Balancing (TAB) is complete per the project specifications.
3. Pre-Functional Testing shall be complete and the completed report shall be issued to the design team prior to SUBSTANTIAL COMPLETION.

For a period not to exceed _____ weeks following immediately after SUBSTANTIAL COMPLETION, the Owner's agents will perform Enhanced Start UP of MEP systems and punch list generation and back punch activities. The contractor will be responsible for assisting in all testing and punch activities including the completion of all adjusting, balancing, repairing, correcting, replacing and completing unacceptable or otherwise incomplete work identified by the design team.

NC State University Design and Construction Guidelines

Supplementary General Conditions

4.0 SGC Article 40 – Utilities, Structures, Signs

- A. UTILITIES FOR NEW BUILDINGS - The Project Expediter will make arrangements with the appropriate utility service providers to provide temporary utilities to the site. The Project Expediter shall bear the costs of providing all temporary utilities to the site and all charges for temporary utilities during the project duration.
- B. UTILITIES FOR EXISTING BUILDINGS – The Project Expediter will make arrangements with either the appropriate utility service providers or with NCSU (if the existing building is already metered) to provide temporary utilities to the site. The University will bear the cost of all temporary utilities except the use of supplemental generators for power. The contractor may use what is available on site without affecting the ongoing operations of the Owner in any way, but may not request additional services that are not already present. Anything additional required by the contractor will be procured and paid for by the contractor

Electricity: \$ _____/KWH (kilo-watt hour)

Water: \$ _____/CCS (hundred cubic feet)

Steam: \$ _____/thousand pounds

Natural gas: \$ _____/deca-therm

SECTION 01 10 00 - 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. This Section includes the following:

1. Project information.
2. Work covered by the Contract Documents
3. Phased construction.
4. Work by Owner.
5. Work under separate contracts.
6. Future work.
7. Owner-furnished products, Contractor-installed products.
8. Access to site.
9. Owner occupancy requirements.
10. Work restrictions.
11. Specification formats and drawing conventions.
12. Seismic Requirement.
13. Substrate for Floor Materials.
14. Miscellaneous Provisions.
 - a. Project Identification and Temporary Signs
 - b. Compliance with industry standards
 - c. Electrical ratings
 - d. References

- B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Doak Field Enhancements, Phase 2

1. Project Location: 1081 Varsity Dr., Raleigh, NC 27606
2. State Construction Office Project No.: 22-24384-01
3. NC State University Project No.: 202120015

4. Designer Project No.; 20220400

B. Owner: State of North Carolina

1. Owning Agency: North Carolina State University, Raleigh, NC
 - a. Point of Contact (Design Phase): Robert Cwikla; (919) 515-6836;
rmcwikla@ncsu.edu.
 - b. Point of Contact (Construction Phase): Mark Michaelson; (919) 513-2752;
mjmichae@ncsu.edu.
 - c. Department: Capital Project Management, Design and Construction
Administrative Services Building III
2601 Wolf Village Way, Suite 331
Raleigh, NC 27695-7520
Campus Box 7520

C. Architect: EwingCole

Architects.Engineers.Interior Designers.Planners
Federal Reserve Bank Building
100 N. 6th Street
Independence Mall West
Philadelphia, Pennsylvania 19106
215-923-2020

8208 Brownleigh Drive, Suite 200
Raleigh, NC 27617
919-460-6700

D. Construction Manager: Romeo Guest, A New South Company.

1715 Camden Ave
Durham, NC 27704
919-683-1701

1. Construction Manager has been engaged for this Project to serve as an advisor to Owner and to provide assistance in administering the Contract for Construction between Owner and each Contractor, according to a separate contract between Owner and Construction Manager.
2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Area A: A 17,000 square-foot addition to the existing Doak Field baseball operations center, containing player training, locker room, and lounge facilities, and extending spectator circulation, seating, and concessions.
2. Area B: Terraced grandstand seating along the third base line with a 1,600 square-foot new construction concession building, adjoining entry gate, and accompanying sitework.

- B. Type of Contract:
 - 1. Project will be administered by Construction Manager as noted above.
 - 2. Project will be constructed under coordinated, concurrent multiple contracts. Contracts for this Project are administered by the Construction Manager.

1.5 PHASED CONSTRUCTION

- A. The Work shall be conducted in two phases, with each phase substantially complete as indicated:
 - 1. Phase 1 (Package B): Field Service Building, associated sitework, and storm management device beyond center field. Work of this phase shall be contracted separately and be substantially complete and ready for occupancy before commencement of the Work described in Phase 2 (Package A).
 - 2. Phase 2 (Package A): The remaining Work shall be substantially complete and ready for occupancy at time of Final Acceptance for the Work.
- B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates, and move-out and -in dates of Owner's personnel for all phases of the Work.

1.6 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 - 1. Phase 1 of the Doak Field Enhancements, described under Package B and administered under separate contract.
- C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
 - 1. No concurrent work will be performed.
- D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.
 - 1. Installation of food service equipment by Owner's designated concessions vendor.

1.7 OWNER-FURNISHED CONTRACTOR-INSTALLED PRODUCTS

- A. Owner will furnish products indicated. The Work includes providing support systems to receive Owner's equipment [and making plumbing, mechanical, and electrical connections].

1. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor.
2. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.
3. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
4. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.
5. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor.
6. Owner will furnish Contractor the earliest possible delivery date for Owner-furnished products. Using Owner-furnished earliest possible delivery dates, Contractor shall designate delivery dates of Owner-furnished items in Contractor's Construction Schedule.
7. Contractor shall review Shop Drawings, Product Data, and Samples and return them to [Architect] [Construction Manager] noting discrepancies or anticipated problems in use of product.
8. Contractor is responsible for receiving, unloading, and handling Owner-furnished items at Project site.
9. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
10. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them.
11. Contractor shall install and otherwise incorporate Owner-furnished items into the Work.

B. Owner-Furnished Products:

1. Fixed spectator seating
2. Athlete lockers.
3. Furniture at Players' Lounge.
4. Room identification signage manufactured by NC State Sign Shop.

1.8 ACCESS TO SITE

- A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Project Area Line.
- B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Owner Occupancy: Allow for Owner occupancy of Project site.
 2. Driveways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.9 OWNER'S OCCUPANCY REQUIREMENTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
 - 2. Comply with requirements and limitations described in NC State University Design and Construction Guidelines, Division 01 NC State's Requirements.
- B. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner. Comply with NC State University Design Guidelines, Division 01 Contractor Safety Guidelines.
- C. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- D. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes. Comply with campus regulation 04.20.03 Smoking Regulation for University Facilities.
- E. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
 - 1. For personnel requiring access to facilities secured by campus infrastructure, coordinate with Owner to provide NC State University standard contractor badge ("All Campus Card").
- F. 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.

1.11 SPECIFICATION FORMATS AND DRAWING CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI/CSC's "MasterFormat" numbering system.
 - 1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 - 2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

- B. 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. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. 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.

- C. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

- D. 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.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.12 SEISMIC REQUIREMENT

- A. All architectural, mechanical, electrical, structural and nonstructural systems, components and elements shall be designed and installed to meet the code requirements of the AHJ, (AUTHORITY HAVING JURISDICTION).

- B. The seismic criteria to be used for these requirements are indicated on Drawing No. S1.2.
- C. The Contractor shall employ a Professional Engineer registered in the jurisdiction for which the project is located to design all restraints necessary to meet the seismic requirements of Specification Divisions 21, 22, 23, 25, 26, 27 and 28. Said Engineer shall sign and seal all drawings and calculations prepared for this purpose.
- D. Where manufactured or pre-engineered items are provided, the manufacturer or fabricator shall provide calculations or certification that the furnished and installed item, including its components and attachments, complies with the requirements of the projects specifications in addition to all code prescribed loadings and criteria, including wind and seismic loading conditions.
- E. Coordinate the installation of all seismic requirements to allow for performance of Special Inspections as indicated in Section 01 41 00 of this specification.

1.13 SUBSTRATE FOR FLOORING MATERIALS

- A. It is the responsibility of the Contractor to provide appropriate substrate, acceptable in writing from the flooring manufacturer, meeting vapor transmission and pH values and flatness required by flooring manufacturer for installation of their product.

1.14 MISCELLANEOUS PROVISIONS

- A. Project Identification and Temporary Signs
 - a. Project Signs – Project signs are not allowed. Directional signs for material deliveries are allowed within the construction area, if required, and shall be 4' wide x 2' high maximum, black and white only. The NCSU Project Manager shall approve the design of the sign and the sign text.
- B. Compliance with Industry Standards
 - 1. Review specified means, methods, techniques, sequences and procedures, including those recommended by manufacturers and referenced standards. Advise the Architect of any specified means, methods, techniques, sequences and procedures which deviate from good construction practice, affect warranties, including the Contractor's general warranty or are objectionable to the Contractor. If any of these conditions exist, the Contractor shall propose in writing to the Architect alternate means, methods, techniques, sequences and procedures for performing the Work.
- C. Electrical Ratings
 - 1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be

submitted for approval and be completed by the Contractor at no additional cost to the Owner.

D. References

1. All references refer to the latest published edition or revision as of the date of the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 13 32 – GEOTECHNICAL DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Reports and information made available to the Architect by the Owner in the preparation of design documents.

1.2 SUMMARY

- A. Existing Reports and Surveys: The Contract Documents do not include soils, geotechnical, hazardous materials or other reports, which may be printed, bound or assembled with the Contract Documents, or otherwise made available to the Contractor(s) for review and information only under this contract, unless specifically enumerated and directly incorporated by reference in the Owner-Contractor Agreement.
- B. Subsurface Investigation Report: A copy of a geotechnical report with respect to the building site is not included with this document. This has been undertaken by the client and is supplied under separate cover.
- C. These reports identify properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of EwingCole and their consultants.
- D. The recommendations described shall not be construed as a requirement of this Contract, unless specifically referenced in the Contract Documents.
- E. These reports, by their nature, cannot reveal all conditions that exist on the site.
- F. The designer does not have knowledge of any hazardous materials underground.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 00 13 32

GEOTECHNICAL REPORT OF SUBSURFACE INVESTIGATION

DOAK FIELD RENOVATIONS

NC STATE UNIVERSITY, RALEIGH, NORTH CAROLINA



PREPARED FOR:
NCSU CAPITAL PROJECT MANAGEMENT
2601 WOLF VILLAGE WAY, SUITE 300
RALEIGH, NORTH CAROLINA 27695-7556

PREPARED BY:
FALCON ENGINEERING, INC.
1210 TRINITY ROAD, SUITE 110
CARY, NORTH CAROLINA 27513

PROJECT NUMBER: G23011.00
JUNE 23, 2023





June 23, 2023

Mr. Bob Cwikla

rmcwikla@ncsu.edu

Project Manager

NCSU Capital Project Management

2601 Wolf Village Way, Suite 300

Raleigh, North Carolina 27695-7556

Re: **Geotechnical Report of Subsurface Investigation**

Doak Field Renovations

NC State University

Raleigh, North Carolina

Falcon Project No.: G23011.00

Dear Mr. Cwikla:

As authorized, Falcon Engineering, Inc. (Falcon) has completed a subsurface investigation for the above referenced project. This subsurface investigation was conducted in March 2023. The opinions and observations rendered in this report are based solely on our review of subsurface data collected by others, site reconnaissance, performance of seven (7) soil test borings, laboratory testing, engineering evaluation of the data obtained, and generally accepted geotechnical engineering practices and principles. Falcon appreciates the opportunity to have provided geotechnical engineering services to North Carolina State University for this project. If you have any questions concerning the contents of this report or need additional information, please do not hesitate to contact our office.

Sincerely,

FALCON ENGINEERING, INC.



Allan Paul, PE

Senior Project Manager / Engineer

A handwritten signature in black ink, appearing to read "Jeremy R. Hamm".

Jeremy R. Hamm, PE

Geotechnical Services Manager

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SECTION 1: PROJECT INFORMATION

This report presents the field and laboratory test procedures and their results and geotechnical recommendations for design and considerations for construction. Our investigation was performed in general accordance with the scope of services outlined in our proposal F2023-002 dated January 17, 2023.

1.1 PROJECT DESCRIPTION

Based on our correspondence and the CAD files provided, it is our understanding the following apply to the project:

- North Carolina State University (NCSU) is underway in design of renovations for Doak Field on Main Campus.
- Ewing Cole is the Project Architect and SKA Consulting Engineers is the Project Structural Engineer.
- The proposed renovations include:
 - Extension of concourse down left field line. Retaining walls are required to achieve concourse level in this area. Current grades have the existing concourse above field level with a slope down to the field beyond.
 - Extension of concourse down right field line. Concourse extension will be approximately 18 feet above a 2-story air-conditioned space.
 - Double-height indoor hitting facility at field level down the right field line near existing batting cages.

Should any of the above information or assumptions made by Falcon be inconsistent with the planned project, we request that you contact us immediately to allow us to make any necessary modifications to this report.

1.2 SITE DESCRIPTION

As depicted on the Site Vicinity Map in Appendix A of this report, the Project Site is located in Raleigh, North Carolina on the main campus of NCSU. The Project Site, Doak Field at Dail Park, originally opened in 1966 and has been used by NCSU since that time. The ballfield has existing stadium seating, press box, ticket building, concessions and bathrooms, batting/pitching cages, and perimeter mast lighting.

1.3 SITE GEOLOGIC DESCRIPTION

The Site is located within the Crabtree Terrane of the Piedmont Physiographic Province of North Carolina. The Piedmont Province lies between the Coastal Plain and the Blue Ridge Mountains and occupies about 45 percent of the area of the state. It is characterized by gently rolling, well-rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys. The terrane consists mostly of metamorphosed igneous, volcanic, and sedimentary rocks. A unique rock of the terrane includes the graphitic schist in the Raleigh area. These rocks were part of a large chain of ancient volcanic islands that formed off the coast of the ancient continent called Gondwana.

According to the *Geologic Map of North Carolina* (1985), bedrock at the Site consists of Felsic mica gneiss (**CZfg**) which is interlayered with graphitic mica schist and mica-garnet schist as well as some minor hornblende gneiss. According to the *Geologic Map of the Raleigh West 7.5-Minute Quadrangle, Wake County, North Carolina* (2008), the Site is located the Horse Creek Schist (**CZhcs**) mapped bedrock unit which is described as silver-gray to tan-gray-white, medium to coarse grained, foliated, lineated, and compositionally layered pelitic metasedimentary rock. In summary, the original fine and coarse grain layers of the parent sedimentary rock have had their minerals foliated (i.e., minerals have been layered) and lineated through metamorphic processes.

SECTION 2: PURPOSE AND SCOPE

Falcon has performed a geotechnical subsurface investigation for the proposed project. The purpose of this investigation is to provide a general characterization of existing onsite soils, rock, and groundwater conditions, as well as design recommendations for earthmoving, groundwater, fill and backfill, lateral earth stress, foundations, and slabs-on-grade.

The project was accomplished through completion of the following tasks:

- Site reconnaissance by Falcon's Geotechnical Engineering personnel.
- Performance of seven (7) Standard Penetration Test (SPT) soil borings.
- Visual-manual classification and stratification of the soil samples according to the Unified Soil Classification System (USCS).
- Laboratory testing of select soil samples collected from the borings.
- Analysis of field and laboratory test data and collected soil samples.
- Preparation of this formal engineering report summarizing the field and laboratory test results and our geotechnical recommendations for design and considerations for construction.

SECTION 3: FIELD INVESTIGATION

3.1 SITE RECONNAISSANCE AND PROJECT SET-UP

Boring locations were selected by others and reviewed by Falcon without any exception. Boring locations were staked in the field by approximating from existing site features. Some minor offsets were made to avoid conflicts with unstable ground conditions, difficult terrain, overhead obstructions, underground utilities, structures, active construction, hardscapes, and vegetation.

Falcon personnel contacted the North Carolina One-Call Center to request subscriber utilities be located and marked in and around the marked boring locations. Utilities were either marked in the field or noted to be specifically not in conflict with the boring locations prior to the beginning of our field investigation.

3.2 SOIL TEST BORINGS

On March 6th, 2023, seven (7) Standard Penetration Test (SPT) soil borings were performed at the Site using a CME 45 rubber-track mounted drill rig equipped with hollow stem augers. SPT borings were performed in general accordance with ASTM D1586 “Penetration Test and Split-Barrel Sampling of Soils”. Soil samples were obtained from test borings at regular intervals using a split-barrel sampler. An automatic hammer was used to advance the sampler at each test interval. All split-spoon soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) by our geotechnical field staff. Soil samples were sealed in moisture retarding containers, labeled, and transported to our laboratory for further analysis. One (1) bulk soil sample consisting of auger cuttings was also collected.

As-drilled boring coordinates were collected with a Trimble GEO7X hand-held GPS unit capable of sub-meter accuracy. The location data was processed through a differential correction procedure and boring locations/coordinates were updated within our file system and CAD drawings.

SECTION 4: LABORATORY TESTING

All split-spoon soil samples were reviewed and visually-manually classified in accordance with ASTM D2488 “Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)” and the Unified Soil Classification System (USCS) by our geotechnical staff. During review of the collected soil samples, a number of representative samples were selected for further analysis in Falcon’s soils laboratory.

- One (1) bulk sample (BS-#) was tested for natural moisture content (ASTM D2216), Atterberg limits (ASTM D4318), mechanical sieve analyses (ASTM D6913), and standard Proctor compaction (ASTM D698).
- Two (2) split-spoon (SS-#) samples were tested for natural moisture content, Atterberg limits, and mechanical sieve analyses.
- Four (4) additional split-spoon samples were tested for natural moisture content only.

Moisture content testing results are shown on the individual Test Boring Logs in Appendix B of this report. A summary of classification test results and bulk sample test results are shown in the tables below. Detailed soil laboratory testing results can be found in Appendix C of this report.

TABLE 4.1: SUMMARY OF LABORATORY INDEX TESTING

SAMPLE ID	BORING ID	DEPTH (FT)	NATURAL MOISTURE CONTENT (%)	PERCENT PASSING			ATTERBERG LIMITS			USCS SYMBOL
				#10	#40	#200	LL	PL	PI	
BS-01	B-01	1.0-18.5	44.7	100	98	89.5	87	57	30	MH
SS-05	B-06	8.5-10.0	39.8	98	94	78.7	41	23	18	CL
SS-06	B-07	6.0-7.5	19.4	85	75	49.8	76	50	26	SM

TABLE 4.2: SUMMARY OF BULK SAMPLE TESTING

SAMPLE ID	BORING ID	DEPTH (FT)	NATURAL MOISTURE CONTENT (%)	OPTIMUM MOISTURE CONTENT (%)	MAXIMUM DRY UNIT WEIGHT (PCF)	USCS SYMBOL
BS-01	B-01	1.0-18.5	44.7	32.6	86.4	MH

SECTION 5: SUBSURFACE CONDITIONS

5.1 SURFACE MATERIALS, SOIL, AND ROCK

Surface materials encountered in the borings consist of topsoil, mulch, sod, and gravel (washed stone). Topsoil measured 3 inches thick at boring B-01 and 3 inches thick at boring B-03. Washed stone measured 12 inches thick at boring B-02 and 36 inches thick at boring B-07. Mulch measured 3 inches thick at boring B-04 and sod measured 3 inches thick at boring B-05. topsoil was encountered at two (2) locations and sod which was encountered at one (1) location. Mulch/sod thickness measured 3 inches where present.

Fill soils are best described as man-placed deposits of materials used to raise or restore grades that typically include soil and rock but can sometimes consist of trash and debris. Fill was identified in all seven (7) soil test borings either at the ground surface or beneath surface materials, extending to approximate depths ranging from 3.0 feet to 14.5 feet below the current ground surface. The fill encountered in the borings was likely placed during construction of the existing ballfield and stadium. Recovered samples of fill were either visually-manually or laboratory classified as poorly-graded gravel (GP), silty sand (SM), clayey sand (SC), silt (ML), lean clay (CL), and elastic silt (MH) with various amounts of gravel, glass fragments, asphalt, roots, and organic debris. Relative moisture of fill samples recovered indicates moist to wet conditions.

Residual soils are formed from the in-place weathering of the parent bedrock. Residual soils were identified below fill soils in all seven (7) borings. Recovered samples of residuum were either laboratory or visually-manually classified as silty sand (SM), silt (ML), lean clay (CL), and elastic silt (MH) with varying amounts of sand, rock fragments, and mica. Relative moisture contents of samples recovered indicates moist to saturated conditions.

5.2 GROUNDWATER MEASUREMENTS

After each boring was drilled, individual boreholes were inspected for the presence of immediate, 0-hour groundwater and cave-in depths were measured. Groundwater was not observed in any borings immediately following drilling. Borings B-03, B-05, and B-07 were backfilled after drilling for safety reasons. The remaining boreholes were left open for at least 24 hours to allow groundwater to stabilize before taking static groundwater measurements and final borehole cave-in depths. Static groundwater was observed in borings B-01 and B-02 at depths of 25.1 and 14.6 feet below the current ground surface, respectively. Static groundwater was not observed in borings B-04 or B-06. Groundwater and borehole cave-in depths are shown on the individual Test Boring Logs. Cave-in depths without observed groundwater may indicate the presence of trapped or static groundwater at or just below the level of cave-in, especially where sandy/saturated soils are present. Boreholes were backfilled with soil cuttings to approximately the same elevation as the surrounding area, mulch-gravel was restored, and excess cuttings were swept up and hauled to a designated area on the grounds for disposal.



TABLE 5.1: SUMMARY OF GROUNDWATER READINGS

BORING ID	CAVE-IN DEPTH	0-HR GROUNDWATER DEPTH (FT)	24-HR GROUNDWATER DEPTH (FT)
B-01	N/M ¹	Dry ²	25.1
B-02	N/M	Dry	14.6
B-03	N/M	Dry	FIAD ³
B-04	15.3	Dry	Dry
B-05	N/M	Dry	FIAD
B-06	15.7	Dry	Dry
B-07	N/M	Dry	FIAD

¹N/M=Not Measured ²Dry=No groundwater observed ³FIAD=Filled Immediately After Drilling

5.3 SUBSURFACE DATA PRESENTATIONS

The Legend to Soil and Rock Classification and Symbols can be used as a reference for symbols, common definitions, or other terminology used in textual/graphical representation of subsurface data. Subsurface conditions at each boring were compiled on to individual Test Boring Logs. A Boring Location Plan was created by overlaying as-drilled boring locations and the CAD files provided to us onto geo-referenced aerial imagery. These documents can all be found in Appendix B of this report.

SECTION 6: GEOTECHNICAL RECOMMENDATIONS AND CONSIDERATIONS

A summary of geotechnical issues with the potential to impact earthmoving and foundations are provided below. Detailed discussions of the geotechnical issues below are provided in the sections which follow.

- **Lightweight, micaceous, moisture-sensitive, elastic silty soils** are present on site in both fill and residual strata. For constructability, limiting their use as structural fill will likely accelerate construction but structural fill may need to be imported to the site at additional cost. These soils may remain in place beneath building pads and foundations.
 - Micaceous, elastic silts are sensitive to damage from exposure to water. Earthmoving operations performed during the wet winter months (generally November to March) or during periods of inclement weather will be difficult and time consuming.
 - Lightweight soils are sensitive to heavy wheel loads. These soils will yield and deform beneath typical proofrolling equipment even if they are well compacted.
 - Micaceous soils perform better when compacted in thinner lifts with compaction effort applied as shearing or kneading action.
- **Shallow Foundations** are able to support the proposed structures. However, due to the somewhat variable fill materials with various debris, a contingency of undercut, geogrid, and engineered fill should be carried to address any organic or deleterious materials encountered at foundation subgrade.

6.1 EARTHMOVING

6.1.1 DEMOLITION, CLEARING, STRIPPING, AND GRUBBING

Stripping and grubbing should be performed at the outset of construction in all planned building areas. Surface materials such as mulch, topsoil, vegetation, concrete, asphalt, and brick are located within the proposed project area. Removal of vegetation should include rootballs as well. These materials should be removed from the site and disposed of in accordance with local, state, and federal regulations.

6.1.2 ENGINEERING BEHAVIOR OF SOILS

After site clearing and demolition, the onsite soils will be exposed to weather events. Extended periods of rain or intrusion of runoff may damage otherwise suitable site subgrades necessitating repair or remediation. Excessive degradation of fill soils can be mitigated by compacting near-surface lifts at, or wet of, optimum moisture and achieving at least 98 percent compaction.

Earthmoving operations performed during wet, winter months (November to March) will be difficult and time consuming (i.e., expensive) as it will require maintaining dry and stable excavations and drying of backfill soils. Traditional drying operations will be minimally effective during this time. Trench excavation spoils should be protected from rain events by covering in plastic sheeting or tarps.

6.1.3 INSPECTION OF SITE SUBGRADES

Once the building pads are established, they should be evaluated by one of Falcon's Geotechnical Engineers or a representative thereof. Any unstable areas and/or highly elastic/plastic soils should be repaired as recommended following filed evaluations. The outcome of subgrade evaluations may vary depending on recent precipitation events and time of year due to the moisture sensitivity of the site soils. Grading activities conducted during wet periods will damage and disturb prepared subgrades and are likely to require more repair than during drier periods.

6.2 SITE EXCAVATION

6.2.1 GENERAL EXCAVATION

Based on the subsurface data obtained, we anticipate site excavations may be completed using small-to-medium sized track mounted hydraulic excavators and rubber tire backhoes.

6.2.2 ROCK EXCAVATION

We do not anticipate rock excavation will be necessary for this project. However, the contract documents should define mass rock, trench rock, and rock payment determination criteria.

6.2.3 EXCAVATION SAFETY

All excavations deeper than 4 feet must conform to applicable sections of the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29CFR1926). In general, compliance will require either sloping back excavations or the use of trench boxes or temporary shoring systems, or some combination of both. The referenced (OSHA) standard should be reviewed for requirements regarding use of sloping and/or trench boxes. The shoring system(s) should be designed to resist lateral earth stresses from existing soils and any nearby structures, account for any adjacent roadways or other infrastructure, and include any surcharge loading for construction equipment or public traffic. Designs should include an appropriate hydrostatic pressure to account for rises in groundwater levels and/or water infiltrating the retained soils. The selected system should consider this condition and the design should address feasible penetration depth. Subsurface conditions, depth of excavations, and horizontal and vertical space constraints will dictate the design of the shoring system along with other considerations such as local availability of materials and equipment. It is the contractor's responsibility to design and construct stable, temporary excavations as part of their safety procedure in accordance with local, state, and federal safety regulations. Falcon does not assume responsibility for construction safety or the contractor's or other party's compliance with applicable safety or other regulations. In addition to the OSHA standards, the Contractor's excavation safety plans should comply with any encroachment or other landowner agreements.

6.3 FILL SELECTION, PLACEMENT, AND BACKFILL

6.3.1 MATERIAL SELECTION

Select granular material is a quarried stone product such as crushed stone screenings, concrete sand, aggregate base course, engineered fill, or processed fill. This material should be used to construct load transfer platforms as discussed elsewhere in this report and to raise grades immediately beneath foundations.

Structural fill is soil material used to raise or restore grades beneath the floor slabs of structures, pavements, and behind retaining walls. Structural fill and backfill shall have a plasticity index of 26 or less, a maximum dry unit weight of at least 90 pounds per square foot, be free of debris, waste, hazardous materials, and particles larger than 3 inches in any dimension, and contain less than 3 percent organic material by weight. Little of the existing fill soil and residual soil on site may be suitable for use as structural fill or backfill. The Project Team should include budgetary allowances for importing structural fill to the site.

Note: Any existing fill or residual soil meeting the requirements for Structural Fill above and having a maximum dry unit of less than 90 pounds per cubic foot may be used as retaining wall backfill provided that those walls are designed with the appropriate Lateral Earth Stress parameters in Table 6.3, adequate drainage is deleted behind the wall, and the wall is not a mechanically stabilized earth (MSE) system for which the wall designer will specify backfill material.

We recommend reaching out to the contractor working on the NCSU ISB project to check if the soil to be excavated from their site could be used at this Project. Alternatively, crushed/recycled concrete from the I-440 project may be a viable source of structural fill.

General fill shall meet the same material requirements described herein with the exception that a maximum particle size of 6 inches should be allowed and the restriction on plasticity index is waived.

6.3.2 PLACEMENT AND COMPACTION

Fill and backfill operations should be continuously monitored and documented. Fill and backfill should be placed in 8 to 10-inch loose lifts when compacted with large, ride-on style compaction equipment. Fill and backfill should be placed in 4 to 6-inch loose lifts when compacted with hand-guided compaction equipment. We recommend fill and backfill be placed and compacted to a uniform, maximum dry unit weight as noted in accordance with the following:

TABLE 6.1: FILL AND BACKFILL REQUIREMENTS

LOCATION	MATERIAL	COMPACTION REQUIREMENTS	MOISTURE REQUIREMENTS
Fill placed beneath pavements or structures	Structural Fill	95% per ASTM D698	2% dry to 2% wet
Fill/backfill in non-structural or non-paved areas	General Fill	90% per ASTM D698	3% dry to 3% wet
Aggregate Base Course beneath pavements	NCDOT Standard ABC Stone	98% per ASTM D1557	2% dry to 2% wet

Soil compaction should be tested in accordance with the sand cone or nuclear density gauge methods at the following minimum frequencies:

TABLE 6.2: MINIMUM COMPACTION TESTING FREQUENCIES

LOCATION	MASS FILL TESTING FREQUENCY	TRENCH BACKFILL TESTING FREQUENCY
Beneath non-structural areas	One (1) test per lift, per 10,000 square feet of fill placed, per fill area, per day	One (1) test per lift, per trench, per day
Beneath pavements or structures	One (1) test per lift, per 2,500 square feet of fill placed, per fill area, per day	One (1) test per lift, per 250 linear feet of backfill placed, per trench, per day

6.4 GROUNDWATER, DEWATERING, DRAINAGE

6.4.1 GROUNDWATER MECHANICS

We do not anticipate the proposed excavations will encounter the groundwater table during construction. Groundwater typically flows in the direction of surface water. Groundwater levels will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall. Consequently, excavations performed during the drier months of the year may yield more favorable groundwater conditions.

6.4.2 SITE DRAINAGE AND DIVERSION

Site drainage within construction areas should be maintained to direct stormwater runoff away from excavations and construction areas. Surface water can generally be controlled or mitigated by constructing drainage ditches, berms, and/or by grading the site to sheet flow toward natural drainage features and away from excavations. The Contractor should sequence operations to provide surface drainage and/or control groundwater by digging gravel pits and placing submersible pumps to

intercept groundwater percolating into excavations. Excavations should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff.

6.5 LATERAL EARTH STRESS

6.5.1 CANTILEVER AND GRAVITY STYLE WALLS

Walls that are free to deflect at the top (e.g., retaining walls) should be designed for an active earth condition and walls that are not free to deflect at the top (e.g., basement, foundation walls, and internally braced walls) should be designed for at-rest conditions. Passive resistance of soils in front of walls may be considered if they are not subjected to erosion or change in density. We recommend using a factor of safety of 1.5 on the passive condition side to accommodate the necessary movement to mobilize passive resistance.

6.5.2 LATERAL EARTH STRESS

Permanent retaining walls and temporary shoring may be designed using the following lateral earth stress parameters:

TABLE 6.3: LATERAL EARTH STRESS PARAMETERS

PARAMETER	BASEMENT AND RETAINING WALLS WITH STRUCTURAL BACKFILL (ON SITE SOIL)	BASEMENT AND RETAINING WALLS WITH STRUCTURAL BACKFILL (IMPORTED)
Moist Unit Weight (pcf)	105	120
Friction Angle (degrees)	26	30
Undrained Shear Strength (tsf)	---	---
At-Rest Earth Stress Coefficient	0.56	0.50
Active Earth Stress Coefficient	0.39	0.33
Passive Earth Stress Coefficient	2.50	3.00
Coefficient of Sliding Friction	0.35	0.35
Equivalent At-Rest Fluid Pressure (psf)	60	60
Equivalent Active Fluid Pressure (psf)	45	40
Equivalent Passive Fluid Pressure (psf)	280	360

These design soil parameters are based on horizontal backfill and no surcharge loading.

6.5.3 DRAINAGE CONSIDERATIONS

Below grade walls (e.g., basement/stem walls) should be designed with waterproofing and a permanent drainage system. Above grade retaining walls (if any) should be designed with dampproofing and a drainage system as well. A typical drainage system consists of a drainage course behind the entire wall and a means to provide grade and outfall for draining water. The drainage course typically consists of a 6 to 24-inch-wide layer of washed stone (#78M, #67, or #57 stone), wrapped in filtration geotextile (such as Mirafi 180N or similar), and a perforated pipe located at the bottom of wall. As an alternative, the washed stone and fabric can be substituted for a minimum 18-inch-wide layer of select granular fill meeting the gradation of concrete sand (ASTM C33) and a prefabricated vertical drainage mat placed immediately against the waterproofing membrane. The perforated pipe is still required for this alternative.

6.6 FOUNDATIONS

6.6.1 SHALLOW FOUNDATIONS

Anticipated maximum column and wall loads have not been provided to us. However, we assume maximum column loads to be on the order of 120 kip and maximum wall loads to be on the order of 10 kip per foot. If actual maximum anticipated loads are provided to us, we can revise our report or issue an addendum accordingly.

We recommend the proposed load bearing columns and walls be supported on single, combined, or continuous shallow foundations bearing on new, controlled structural fill, approved existing fill, or firm or better ($N > 4$) residual soil and be designed for a net allowable bearing capacity of 2,000 psf. We recommend using a coefficient of sliding friction equal to 0.35 may be used for foundations cast directly upon soil.

Based on the subsurface conditions encountered, the total settlement is estimated to be 1 inch or less and the amount of differential settlement across individual structures is expected to be ½ inch or less provided the recommendations/requirements described in Section 6.3 and elsewhere herein are adhered to. The magnitude of settlement for the structure will depend on actual structural loads, variations in the subsurface soil profile, and the quality of earthwork and foundation construction.

6.6.2 ADDITIONAL CONSIDERATIONS

The availability of the allowable bearing pressure is predicated upon Falcon's ability to review grading and foundation drawings, to inspect site subgrades prior to new fill placement, to inspect and test fill compaction during foundation and building pad construction, and to inspect and/or test all foundation subgrades to verify subsurface conditions prior placement of stone, reinforcements, and concrete. Offending soils encountered at and below footing subgrades will require repair under the direction of Falcon's Geotechnical Engineer.

Undercut will be required if soft soils or fill laden with organic debris are encountered. Undercut foundations should be backfilled with structural fill and geosynthetics if necessary. Washed stone of any gradation (#78M, #67, or #57) should not be used as foundation undercut backfill. We recommend the Contract Documents include an allowance for undercutting 16 inches throughout one-third of the total buildings' perimeters or 75 cubic yards, whichever is greater. Undercut areas should be backfilled with engineered fill, ABC stone, or crushed stone screenings imported to the site. We recommend a contingency allowance of 200 square yards of biaxial geogrid should also be included in the contract.

Expansion joints should be provided at building breaks and on exterior walls at regular intervals in accordance with ACI guidelines. Exterior foundations and foundations in unheated areas should be designed to bear at least 18 inches below finished grades for frost protection. Footings should be designed such that no utility lines, utility line excavation, or any other footings are located within a 1:1 zone of influence of the subject footing edge.

6.6.3 PROTECTION OF FOUNDATION SUBGRADES

Foundation subgrade soils are sensitive to moisture intrusion and should be protected from surface water flows and infiltration. Positive drainage should be provided to direct surface water flows away from the building areas. Foundation excavations should be covered or otherwise protected during rainfall events. If construction occurs during inclement weather and concreting of the foundation is not possible at the time it is excavated, basement foundations should be slightly over-excavated, and an approximately 2-inch-thick layer of lean (750 psi $< f_c < 2,000$ psi) concrete also known as a "mud mat"

should be placed on the bearing surface for protection from water intrusion. Previously approved foundation excavations that are subsequently exposed to excess moisture shall be re-observed and repaired as determined by Falcon's Geotechnical Engineer, prior to foundation concrete placement.

6.7 SLABS-ON-GRADE

6.7.1 BUILDING PADS

Prior to placement of aggregate base for slabs-on-grade, building pads should be proofrolled with a fully-loaded, tandem-axle dump truck in the presence of Falcon's Geotechnical Engineer or otherwise evaluated. Areas of underperforming soils should be repaired. We anticipate some deterioration of pad subgrade will occur when exposed to the elements especially during the winter months. Building pads will also deteriorate under repeated construction traffic and prolonged weather events. The building pad should be graded with a crown to promote positive drainage and water should not be allowed to sit on the building pad for extended periods of time.

Based on our experience, erection of elevated levels prior to placement of the slab-on-grade concrete will make drying of the building pad difficult. Therefore, after the building pad has been established, evaluated, and approved, we recommend placing 5 inch thick layer of NCDOT ABC stone to cap and protect the building pad from moisture intrusion. This aggregate will also serve as a working platform for crews and capillary break for moisture.

Provisions should be made for the installation of vapor retarder to minimize moisture-vapor transmission per ACI beneath occupied structures.

6.7.2 SLAB-ON-GRADE DESIGN CONSIDERATIONS

Liberal jointing patterns should be employed throughout the slab areas per ACI guidelines for crack control purposes. Design of the floor slab may be based on a modulus of subgrade reaction of 150 pci as related to a standard 12-inch diameter plate load test.

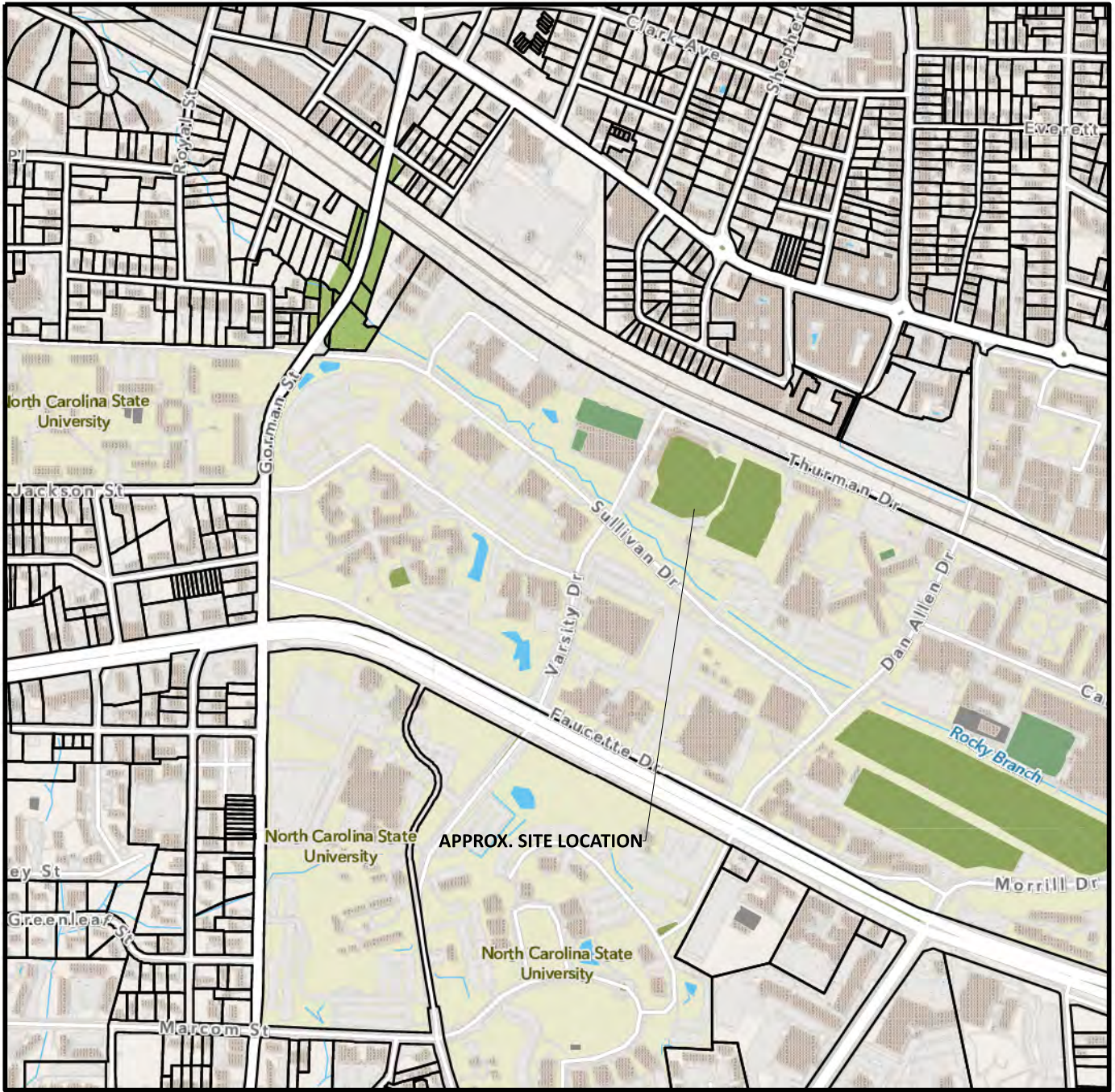
SECTION 7 CLOSURE

Recommendations and evaluations provided by Falcon are based on the project description as outlined herein. Modifications of our recommendations and evaluations may be required as design progresses. Recommendations in this report are based on data obtained from our subsurface field exploration and laboratory testing programs. The nature and extent of variations between borings may not become evident until construction, although more insight may be provided by additional field testing data.

Our professional services for this project have been performed in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. Falcon appreciates this opportunity to have provided you with geotechnical engineering services for this project. If you have any questions regarding this report, please contact our office at 919.871.0800.

APPENDIX A


SITE VICINITY MAP A-1



NAD 83 / NEPS 2007

NOTES:

1. Imagery obtained from Wake County GIS website:
<https://maps.raleighnc.gov/imaps/>

SHEET NAME: SITE VICINITY MAP		 <p>FALCON ENGINEERING, INC. 1210 TRINITY ROAD, SUITE 110 CARY, NC 27513 PHONE: 919.871.0800 www.falconengineers.com</p>
PROJECT NAME: DOAK FIELD RENOVATIONS		
PROJECT NO.: G23011.00		
PROJECT LOCATION: RALEIGH, NC		SCALE: 1"=800'
INVESTIGATED BY: JRH	DRAWN BY: EJB	CHECKED BY: ASP
		DATE: 2021-09-10

APPENDIX B

LEGEND TO SOIL AND ROCK CLASSIFICATIONS AND SYMBOLS B-1

BORING LOCATION PLAN B-2

TEST BORING LOGS..... B-3

LEGEND TO SOIL AND ROCK CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)	FRACTURE SPACING	CONSISTENCY OF COHESIVE SOILS		RELATIVE DENSITY OF COHESIONLESS SOILS
SYMBOLS	TERM	TERM	CONSISTENCY	STANDARD PENETRATION BLOWS PER FOOT
BITUMINOUS CONCRETE (ASPHALT)	VERY WIDE	MORE THAN 10 FEET	VERY SOFT	0 TO 2
CONCRETE	WIDE	3 TO 10 FEET	SOFT	3 TO 4
AGGREGATE BASE COURSE	MODERATELY CLOSE	1 TO 3 FEET	FIRM	5 TO 8
TOPSOIL	CLOSE	0.16 TO 1 FEET	STIFF	9 TO 15
LOW-PLASTICITY ORGANIC SILT/CLAY (OL)	VERY CLOSE	LESS THAN 0.16 FEET	VERY STIFF	16 TO 30
HIGH-PLASTICITY ORGANIC SILT/CLAY (OH)			HARD	31 TO 50
PEAT (PT)			VERY HARD	OVER 50
WELL-GRADED GRAVEL (GW)				
POORLY-GRADED GRAVEL (GP)				
SILTY GRAVEL (GM)				
CLAYEY GRAVEL (GC)				
WELL-GRADED SAND (SW)				
POORLY-GRADED SAND (SP)				
SILTY SAND (SM)				
CLAYEY SAND (SC)				
SILT (ML)				
ELASTIC SILT (MH)				
LEAN CLAY (CL)				
PLASTIC CLAY (CH)				
PARTIALLY WEATHERED ROCK				
NON-CRYSTALLINE ROCK				
CRYSTALLINE ROCK				
COASTAL PLAIN SEDIMENTARY ROCK				
MAN PLACED FILL OR BACKFILL				
ALLUVIAL SOILS				
IMMEDIATE WATER LEVEL				
STATIC WATER LEVEL				
PIPE INVERT ELEVATION				
AUGER PROBING				
SPT BORING				
SPT BORING WITH ROCK CORE				
CONE PENETRATION TEST SOUNDING				
HAND AUGER + TEST				
ROD SOUNDING				
TEST PIT				
SPT N-VALUE				
SS SPLIT SPOON SAMPLE				
BS BULK SAMPLE				
ST SHELBY TUBE SAMPLE				
RS ROCK SAMPLE				

WEATHERING

FRESH	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
VERY SLIGHT (V. SL.)	Rock generally fresh, joints stained, some joints may show thin clay coatings if open, crystals on a broken specimens face shine brightly. Rock rings under hammer blows if of a crystalline nature.
SLIGHT (SLI.)	Rock generally fresh, joints stained and discoloration extends into rock up to 1 inch. Open joints may contain may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rock rings under hammer blows.
MODERATE (MOD.)	Significant portions of rock shows discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored, some show clay. Rock has dull sound under hammer blows and show significant loss of strength as compared with fresh rock.
MODERATE SEVERE (MOD. SEV.)	All rocks except quartz discolored or stained. In granitoid rocks, all feldspars and discolored and a majority show kaolinitization. Rocks shows severe loss of strength and can be excavated with a geologist's pick. Rock gives "clunk" sound when struck. If tested would yield spt refusal.
SEVERE (SEV.)	All rocks except quartz discolored or stained. Rock fabric clear and evident but reduced in strength to strong soil. In granitoid rocks all feldspars are kaolinitized to some extent. Some fragments of strong rock usually remain. If tested, yields spt n-values > 100 bpf.
VERY SEVERE (V. SEV.)	All rocks except quartz discolored or stained. Rock fabric elements are discernible but the mass is effectively reduced to soil status, with only fragments of strong rock remaining. Saprolite is an example of rock weathered to a degree such that only minor vestiges of the original rock fabric remain. If tested, yields spt n-values < 100 bpf.
COMPLETE	Rock reduced to soil. Rock fabric not discernible or discernible only in small and scattered concentrations. Quartz may be present as dikes or stringers. Saprolite is also an example.

ROCK HARDNESS

VERY HARD	Cannot be scratched by knife or sharp pick. Breaking of hand specimens requires several hard blows of the geologist's pick.
HARD	Can be scratched by knife or pick only with difficulty. Hard hammer blows required to detach hand specimens.
MODERATELY HARD	Can be scratched by knife or pick. Gouges or grooves to 0.25 inches deep can be excavated by hard blow of a geologist's pick. Hand specimens can be detached with moderate blows.
MEDIUM HARD	Can be grooved or gouged 0.5 inches deep by firm pressure of knife or pick point. Can be excavated in small chips to pieces 1 inch maximum size by hard blows of the point of a geologist's pick.
SOFT	Can be grooved or gouged readily by knife or pick. Can be excavated in fragments from chips to several inches in size by moderate blows of a pick point. Small, thin pieces can be broken by finger pressure.
VERY SOFT	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken by finger pressure. Can be scratched readily by fingernail.

ROCK DEFINITION

Hard rock is non-coastal plain material that when tested, would yield spt refusal. An inferred rock line indicates the level at which non-coastal plain material would yield SPT refusal. SPT refusal is penetration by a split-spoon sampler equal to or less than 0.1 foot per 50 blows. In non-coastal plain material, the transition between soil and rock materials are typically divided as follows:

PARTIALLY WEATHERED ROCK (PWR)		Non-coastal plain material that yields SPT N-values > 100 blows per foot.
CRYSTALLINE ROCK (CR)		Fine to coarse grained, igneous and metamorphic rock that would yield SPT refusal if tested. Rock type includes granite, gneiss, gabbro, schist, etc.
NON-CRYSTALLINE ROCK (NCR)		Fine to coarse grained, metamorphic and non-coastal plain sedimentary rock that would yield SPT refusal if tested. Rock type includes phyllite, slate, sandstone, etc.
COASTAL PLAIN SEDIMENTARY ROCK (CP)		Coastal plain sediments cemented tinto rock but may not yield SPT refusal. Rocky type includes limestone, sandstone, cemented shell beds, etc.

ABBREVIATIONS

ABC	Aggregate base course	FIAD	Filled immediately after drilling	RES	Residuum
ALLUV	Alluvium	FOSS	Fossiliferous	SAP	Saprolitic
AR	Auger refusal	FRAC	Fractured	S	Soft
BC	Bituminous concrete (asphalt)	FRAGS	Fragments	SAT	Saturated
BLDR	Boulder	GR	Gravel	SD	Sand
BPF	Blows per foot	GS	Specific gravity	SDY	Sandy
BT	Boring terminated	GW	Groundwater	SED	Sediments
CALC	Calcareous	HR	Hard rock	SL	Silt, silty
CI	Caved-in	MED	Medium	SLI	Slightly
CL	Clay	MIC	Micaceous	SPT	Standard penetration test
CLY	Clayey	MOT	Mottled	SWR	Soft weathered rock
COB	Cobble	NS	No sample taken	TCR	Tricone refusal
CSE	Coarse	ORG	Organic	TS	Topsoil
DPT	Dynamic penetration test	PP	Pocket penetrometer	VST	Vane shear test
EST	Estimated	PWR	Partially weathered rock	V	Very
F	Fine	REF	Refusal	W/	With

TERMS AND DEFINITIONS

- **ALLUVIUM:** soils which have been transported and deposited by water.
- **AQUIFER:** a water bearing formation or strata.
- **ARENACEOUS:** applied to rocks that have been derived from sand or that contain sand. Argillaceous: applied to all rocks or substances composed of clay minerals, or having a notable proportion of clay in their composition, as shale/slate/etc.
- **ARTESIAN:** groundwater that is under sufficient pressure to rise above the level at which it is encountered, but which does not necessarily rise to or above the ground surface
- **CALCAREOUS:** soils which contain appreciable amounts of calcium carbonate.
- **COLLUVIUM:** rock fragments mixed with soil deposited by gravity on a slope or bottom of a slope.
- **CORE RECOVERY:** total length of all material recovered in the core barrel divided by total length of core run and expressed as a percentage.
- **DIKE:** a tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rock.
- **DIP:** the angle at which a stratum or any planar feature is inclined from the horizontal.
- **DIP DIRECTION:** the direction or bearing of the horizontal trace of the line of dip, measured clockwise from north.
- **FAULT:** a fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.
- **FILL:** man-made deposits of natural soils or rock products and waste materials.
- **FISSE:** a property of splitting along closely spaced parallel planes.
- **FLOAT:** rock fragments on surface near their original position and dislodged from parent material.
- **FLOOD PLAIN:** land bordering a stream, built of sediments deposited by the stream.
- **FORMATION:** a mappable geologic unit that can be recognized and traced in the field.
- **JOINT:** fracture in rock along which no appreciable movement has occurred.
- **LEDGE:** a shelf-like ridge or projection of rock whose thickness is small compared to its lateral extent.
- **LENS:** a body of soil or rock that thins out in one or more directions.
- **MOTTLED:** irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.
- **PERCHED WATER:** water maintained above the normal groundwater level by the presence of an intervening impervious stratum.
- **RESIDUUM:** soil formed in place by weathering of the parent rock.
- **ROCK QUALITY DESIGNATION (ROD):** a measure of rock quality described by: total length of rock segments equal to or greater than 4 inches divided by the total length of core run and expressed as a percentage.
- **SAPROLITE:** residual soil which retains the relic structure or fabric of the parent rock.
- **SILL:** an intrusive body of igneous rock of approximately uniform thickness and relatively thin compared with its lateral extent, which has been emplaced parallel to the bedding or schistosity of the intruded rocks.
- **SLICKENSIDE:** polished and striated surface that results from friction along a fault or slip plane.
- **STANDARD PENETRATION TEST (SPT):** number of blows of a 140 pound hammer falling 30 inches required to produce a penetration of 1 foot (N-value or blows per foot) into soil with a 2 in outside diameter split spoon sampler. SPT refusal is less than 0.1 foot penetration with 50 blows.
- **STRATA CORE RECOVERY:** total length of strata material recovered divided by total length of stratum and expressed as a percentage.
- **STRATA ROCK QUALITY DESIGNATION:** a measure of rock quality described by total length of rock segments within a stratum equal to or greater than 4 inches divided by the total length of strata and expressed as a percentage.
- **STRATUM:** a section of a formation consisting of the same kind of material throughout.
- **TOPSOIL:** surface soils usually containing organic material.



NOTES:
 1. Georeferenced aerial imagery referenced from www.NCOneMap.gov.

SHEET NAME: BORING LOCATION PLAN	
PROJECT NAME: DOAK FIELD RENOVATIONS	
PROJECT NO.: G23011.00	
PROJECT LOCATION: RALEIGH, NC	
INVESTIGATED BY: JRH	DRAWN BY: EJB
CHECKED BY: ASP	SCALE: 1"=100'
DATE: 2021-09-10	



FALCON ENGINEERING, INC.
 1210 TRINITY ROAD, SUITE 110
 CARY, NC 27513
 PHONE: 919.871.0800
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PROJECT NO. G23011.00		PROJECT LOCATION Raleigh, NC		LOGGED BY Hamm, J.		GROUND WATER	0 HOUR	STATIC
PROJECT NAME Doak Field Renovations						HOLE	Dry	▼
BORING NO. B-01		BORING LOCATION See Boring Location Plan				DEPTH		25.1
ELEVATION (ft)		NORTHING (ft) 741786		DRILL MACHINE CME 45 TRACK		DATE	3/6/2023	3/7/2023
TOTAL DEPTH (ft) 40.0		EASTING (ft) 2095153		DRILLER Radford, J.		SURFACE WATER DEPTH (ft) N/A		
DATE STARTED 3/6/2023			DATE COMPLETED 3/6/2023		DRILL METHOD HSA		HAMMER TYPE Automatic	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					MOISTURE	LAB NO. DEPTH	LOG	Elev. (ft)	SOIL AND ROCK DESCRIPTION GROUNDWATER READINGS	Depth (ft)	
		0.5 ft	0.5 ft	0.5 ft	0	20	40	60	80							100
	1.0	5	9	8												0.0
	3.5	2	3	5												0.3
	6.0	14	17	20												
	8.5	4	6	7												
	13.5	2	3	4												
	18.5	1	2	3												
	23.5	2	3	4												
	28.5	2	2	3												
	33.5	2	5	7												
	38.5	2	4	5												
	40.0															
Boring Terminated at 40.0 feet Below Current Ground Surface in RESIDUUM																

01 TEST BORING LOG G23011.00.GPJ FALCON FORMAT.GDT 6/21/23

Vertical Scale: 1"=6'



PROJECT NO. G23011.00		PROJECT LOCATION Raleigh, NC		LOGGED BY Hamm, J.		GROUND WATER	0 HOUR	STATIC
PROJECT NAME Doak Field Renovations						HOLE	Dry	▼
BORING NO. B-02		BORING LOCATION See Boring Location Plan				DEPTH		14.6
ELEVATION (ft)		NORTHING (ft) 741634		DRILL MACHINE CME 45 TRACK		DATE	3/6/2023	3/7/2023
TOTAL DEPTH (ft) 20.0		EASTING (ft) 2095234		DRILLER Radford, J.		SURFACE WATER DEPTH (ft) N/A		
DATE STARTED 3/6/2023			DATE COMPLETED 3/6/2023		DRILL METHOD HSA		HAMMER TYPE Automatic	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					MOISTURE	LAB NO. DEPTH	LOG	Elev. (ft)	SOIL AND ROCK DESCRIPTION GROUNDWATER READINGS	Depth (ft)	
		0.5 ft	0.5 ft	0.5 ft	0	20	40	60	80							100
	1.0	3	3	3												0.0
	3.5	2	3	4						Moist						1.0
	6.0	6	7	8						32.8%	SS-01					3.0
	8.5	2	1	3						Moist						
	13.5	1	2	2						Wet						
	18.5	1	2	3						Wet						
										Wet						20.0
Boring Terminated at 20.0 feet Below Current Ground Surface in RESIDUUM																

01 TEST BORING LOG: G23011.00.GPJ FALCON_FORMAT.GDT 6/21/23

Vertical Scale: 1"=6'



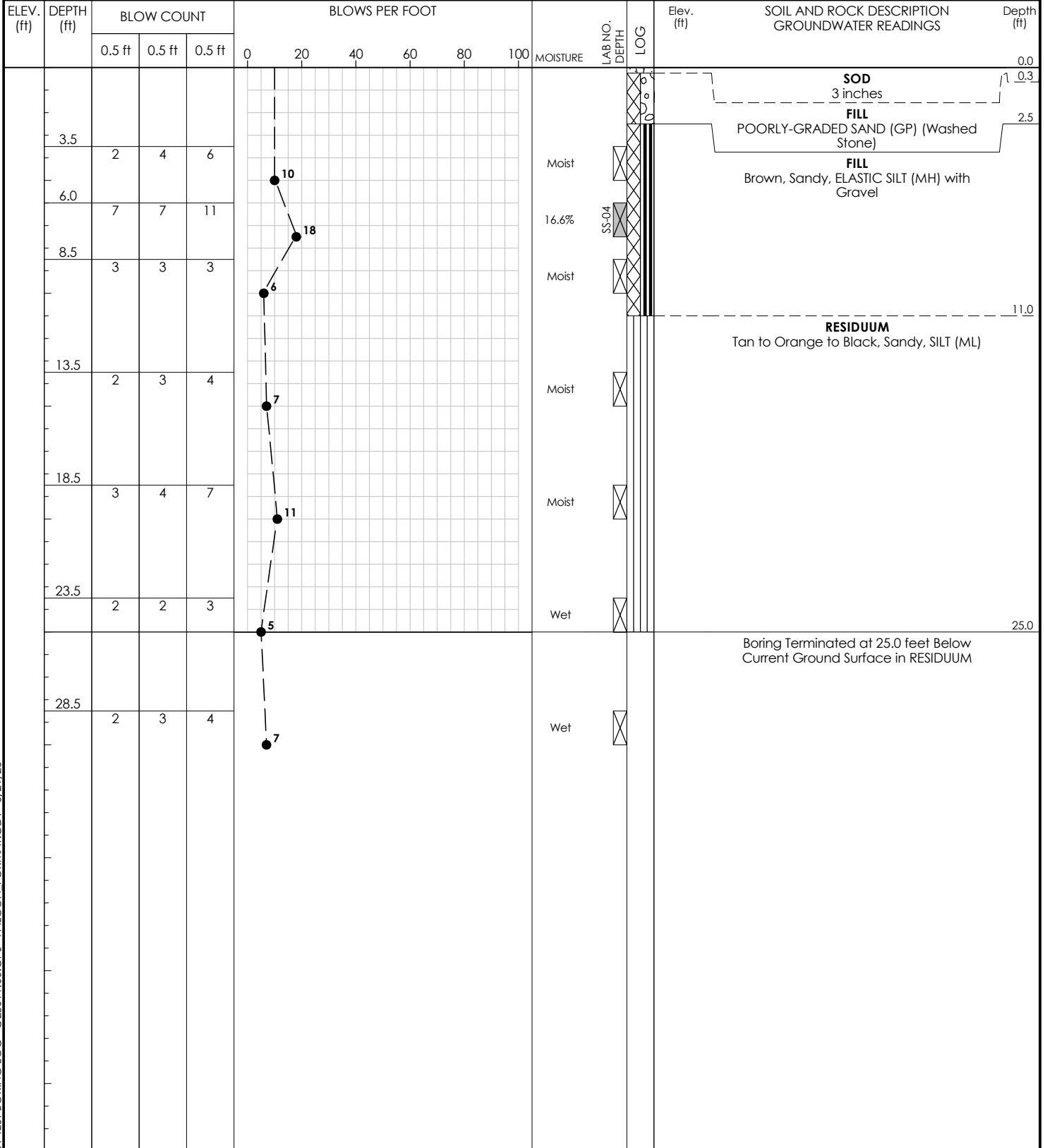
PROJECT NO. G23011.00		PROJECT LOCATION Raleigh, NC			LOGGED BY Hamm, J.		GROUND WATER	0 HOUR	STATIC					
PROJECT NAME Doak Field Renovations							HOLE		FIAD					
BORING NO. B-03		BORING LOCATION See Boring Location Plan			DRILL MACHINE CME 45 TRACK		DEPTH							
ELEVATION (ft)		NORTHING (ft) 741631		DRILLER Radford, J.		DATE 3/6/2023								
TOTAL DEPTH (ft) 25.0		EASTING (ft) 2094797		DRILL METHOD HSA		SURFACE WATER DEPTH (ft) N/A								
DATE STARTED 3/6/2023		DATE COMPLETED 3/6/2023		DRILL METHOD HSA		HAMMER TYPE Automatic								
ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					MOISTURE	LAB NO. DEPTH LOG	SOIL AND ROCK DESCRIPTION GROUNDWATER READINGS	Depth (ft)	
		0.5 ft	0.5 ft	0.5 ft	0	20	40	60	80					100
	1.0	2	3	4							27.1%	SS-02	TOPSOIL 3 inches	0.0 0.3
	3.5	2	2	4							Moist		FILL Orange, Sandy, SILT (ML)	3.0
	6.0	6	7	7							Moist		Orange to Brown and Tan, Sandy, ELASTIC SILT (MH) with Organics, at 5.0 feet, Gravel in 6.0 sample	
	8.5	3	3	4							Moist		RESIDUUM Gray and Tan to Black, Micaceous, Sandy, SILT (ML)	9.0
	13.5	1	2	2							Moist			
	18.5	2	2	3							Moist			
	23.5	2	3	4							Moist			
														25.0
													Boring Terminated at 25.0 feet Below Current Ground Surface in RESIDUUM	

01 TEST BORING LOG: G23011.00.GPJ FALCON FORMAT.GDT 6/21/23

Vertical Scale: 1"=6'



PROJECT NO. G23011.00		PROJECT LOCATION Raleigh, NC		LOGGED BY Hamm, J.		GROUND WATER	0 HOUR	STATIC
PROJECT NAME Doak Field Renovations						HOLE		FIAD
BORING NO. B-05		BORING LOCATION See Boring Location Plan				DEPTH		
ELEVATION (ft)		NORTHING (ft) 741549		DRILL MACHINE CME 45 TRACK		DATE	3/6/2023	
TOTAL DEPTH (ft) 25.0		EASTING (ft) 2094851		DRILLER Radford, J.		SURFACE WATER DEPTH (ft) N/A		
DATE STARTED 3/6/2023			DATE COMPLETED 3/6/2023		DRILL METHOD HSA		HAMMER TYPE Automatic	



01 TEST BORING LOG: G23011.00.GPJ FALCON FORMAT.GDT 6/21/23

Vertical Scale: 1"=6'



PROJECT NO. G23011.00		PROJECT LOCATION Raleigh, NC		LOGGED BY Hamm, J.		GROUND WATER	0 HOUR	STATIC
PROJECT NAME Doak Field Renovations						HOLE	Dry	Dry
BORING NO. B-06		BORING LOCATION See Boring Location Plan				DEPTH		
ELEVATION (ft)		NORTHING (ft) 741486		DRILL MACHINE CME 45 TRACK		DATE 3/6/2023 3/7/2023		
TOTAL DEPTH (ft) 20.0		EASTING (ft) 2094734		DRILLER Radford, J.		SURFACE WATER DEPTH (ft) N/A		
DATE STARTED 3/6/2023		DATE COMPLETED 3/6/2023		DRILL METHOD HSA		HAMMER TYPE Automatic		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					MOISTURE	LAB NO. DEPTH	LOG	Elev. (ft)	SOIL AND ROCK DESCRIPTION GROUNDWATER READINGS	Depth (ft)	
		0.5 ft	0.5 ft	0.5 ft	0	20	40	60	80							100
	1.0	2	2	3							Moist				FILL Reddish Orange and Brown, LEAN CLAY (CL) with Gravel	0.0
	3.5	2	3	3							Moist					5.5
	6.0	1	1	2							Moist				Reddish Orange and Brown, ELASTIC SILT (MH) with Mica	8.0
	8.5	2	2	2							39.8%	SS-05			RESIDUUM Black, LEAN CLAY (CL) with Sand	11.5
	13.5	4	5	4							Moist				Gray and Brown, Clayey, SILT (ML)	15.7
	18.5	1	1	2							Moist					Cave-in 15.7
																20.0
Boring Terminated at 20.0 feet Below Current Ground Surface in RESIDUUM																

01 TEST BORING LOG: G23011.00.GPJ FALCON_FORMAT.GDT 6/21/23

Vertical Scale: 1"=6'

APPENDIX C

SUMMARY OF SOIL INDEX TESTING..... C-1

LABORATORY COMPACTION CURVES..... C-2

ATTERBERG LIMITS RESULTS..... C-3

GRAIN SIZE DISTRIBUTION RESULTS..... C-4



FALCON ENGINEERING, INC.
 1210 TRINITY ROAD, SUITE 110
 CARY, NC 27513

PHONE: 919.871.0800
 www.falconengineers.com

SUMMARY OF SOIL INDEX TESTING

PAGE 1 OF 1

Project Number: G23011.00												
Project Name: Doak Field Renovations												
Project Location: Raleigh, NC												
Sample ID	Boring ID	Depth (ft)	Natural Moisture Content (%)	Percent Passing			Atterberg Limits			Percent Organics	Symbol	
				#10	#40	#200	LL	PL	PI		USCS	AASHTO
BS-01	B-01	1.0 - 18.5	44.7	100	99	89.5	87	57	30	-	MH	A-7-5
SS-01	B-02	3.5 - 5.0	32.8							-		
SS-02	B-03	1.0 - 2.5	27.1							-		
SS-03	B-04	3.5 - 5.0	26.7							-		
SS-04	B-05	6.0 - 7.5	16.6							-		
SS-05	B-06	8.5 - 10.0	39.8	98	94	78.7	41	23	18	-	CL	A-7-6
SS-06	B-07	6.0 - 7.5	19.4	85	75	49.8	76	50	26	-	SM	A-7-5



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 1210 TRINITY ROAD, SUITE 110
 CARY, NC 27513

PHONE: 919.871.0800
 www.falconengineers.com

LABORATORY COMPACTION TEST RESULTS

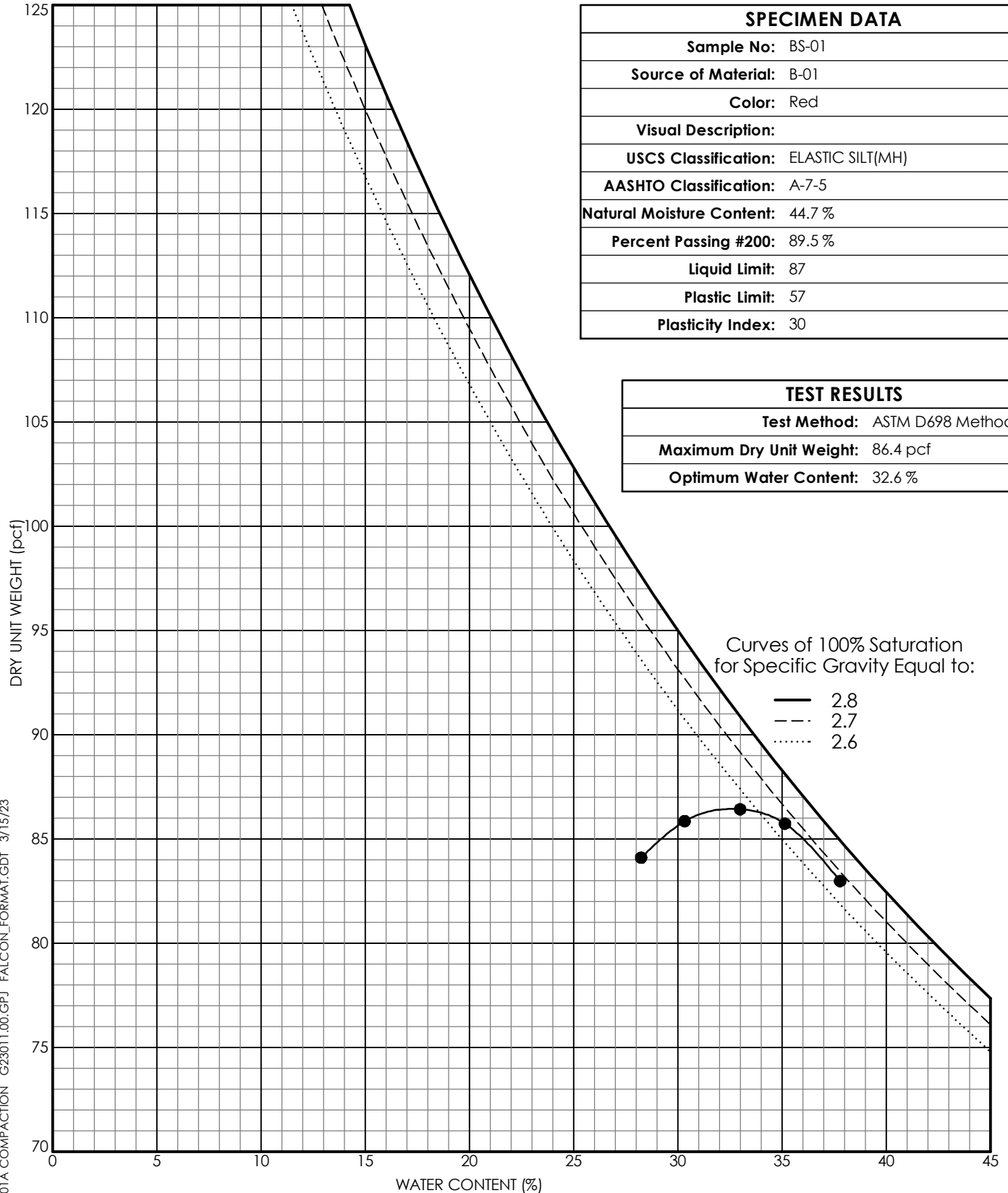
Project No.: G23011.00

Project Name: Doak Field Renovations

Project Location: Raleigh, NC

SPECIMEN DATA	
Sample No:	BS-01
Source of Material:	B-01
Color:	Red
Visual Description:	
USCS Classification:	ELASTIC SILT(MH)
AASHTO Classification:	A-7-5
Natural Moisture Content:	44.7 %
Percent Passing #200:	89.5 %
Liquid Limit:	87
Plastic Limit:	57
Plasticity Index:	30

TEST RESULTS	
Test Method:	ASTM D698 Method A
Maximum Dry Unit Weight:	86.4 pcf
Optimum Water Content:	32.6 %



SECTION 01 23 00 - ALTERNATES

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. This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if accepted by the Owner and enumerated in the Agreement.
 - 2. The cost for each alternate is the net addition to the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
- B. Preferred Brand Alternate: An amount proposed by bidders and stated on the Bid Form for use of products and materials in the Work that are preferred or required by the Owner as allowed under NCGS 133-3. Specifications to carry competitive items; substitution of materials.
 - 1. Preferred Brand Alternates described in this Section are part of the Work only if accepted by the Owner and enumerated in the Agreement.
 - 2. The cost for each Preferred Brand Alternate is the net addition to the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other work of the Contract.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF PREFERRED BRAND ALTERNATES

- A. Alternate No. PBA-C1: Campus standards for Utilities
1. Base Bid: Provide Fire Hydrants from acceptable manufacturer as specified in Section 33 11 00 "Water Utility Distribution Systems."
 2. Alternate: Provide Fire Hydrants by Mueller.
- B. Alternate No. PBA-L1: Campus standards for Brick Pavers
1. Base Bid: Provide paver brick meeting requirements of Section 04 20 00 "Unit Masonry."
 2. Alternate: Provide paver brick by Pine Hall Brick (Winston Salem, NC) as follows:
 - a. Pedestrian Walks: Pathway Full Range
 - 1) Traditional Edge
 - 2) 4" x 8" x 2 1/4"
 - b. Heavy Vehicular Traffic: English Edge Full Range
 - 1) 4" x 8" x 2 3/4"
 - c. Accessible Curb Ramps: Brick Inset
 - 1) Dark Accent
 - 2) English Edge
 - 3) 4" x 8" x 2 1/4"
- C. Alternate No. PBA-L2: Campus standards for Irrigation Controllers
1. Base Bid: Provide irrigation controller meeting Owner's requirements.
 2. Alternate: Provide irrigation controller from Rain Bird, model ESP-MC.
- D. Alternate No. PBA-A1: Campus standards for Electrified Door Hardware
1. Base Bid: Provide electrified door hardware meeting the requirements of Section 08 71 00 "Door Hardware."
 2. Alternate: Provide electrified door hardware as follows:
 - a. Card Access Control and Video Systems and Equipment
 - 1) Access Control System and Equipment: Software House 9000
 - 2) Video Platform: Genetec
 - 3) CCTV Cameras: Axis Communications
 - b. Electrified Mortise Locksets: Schlage L9092EU with LX/RX/DPS.
 - 1) Finish: US26D
 - c. Electrified Access Control Exit Device: Von Duprin 98/99/33 Series QEL with LX/RX switch
 - 1) Finish: US26D

- d. Wireless Access Control Locksets: Schlage LE Greenwich with DPS
 - 1) Finish: US26D
- e. Door Hardware Power Supplies:
 - 1) Field Application: Altronix AL600ULACMCB with Access Module
 - 2) Security Headend Application: Altronix Maximal 33
 - 3) Security Headend Application: LifeSafety Power NetLink Integration with C-CURE 9000
 - 4) Onboard battery backup is required.
- f. Electro-mech Transfer Plate Hinge: 8-conductor transfer with minimum 18ga power pair from one of the following manufacturers:
 - 1) Stanley
 - 2) Command Access
 - 3) Hager

E. Alternate No. PBA-A2: Campus standards for Mechanical Door Hardware

- 1. Base Bid: Provide mechanical door hardware meeting the requirements of Section 08 71 00 "Door Hardware."
- 2. Alternate: Provide mechanical door hardware as follows:
 - a. Mortise Locks, Key in Levers, Cylindrical deadbolts:
 - 1) Acceptable manufacturers: Best, Schlage
 - 2) Finish: US26D
 - 3) Core: small format
 - b. Panic Hardware and Strikes:
 - 1) Acceptable manufacturer: Von Duprin
 - 2) Latching: Rim, vertical rod, mortise
 - c. Fire-rated Exit Devices:
 - 1) Acceptable manufacturer: Von Duprin
 - 2) Model: 626, 628
 - 3) Latching: Rim, vertical rod, mortise
 - d. Key blanks: 7-pin small format capable of interfacing with Best A2 and A4 systems
 - 1) Acceptable manufacturers: Schlage, Best

F. Alternate No. PBA-A3: Campus standards for Elevators and Conveyances

- 1. Base Bid: Provide conveyance elements meeting the requirements of Division 14.
- 2. Alternate: Provide conveyance elements as follows:
 - a. Controls: Smartrise Controller
 - 1) Traction Applications: C4
 - 2) Hydraulic Applications: SRH
 - b. Elevator Telephone: Gaitronics model 297
 - c. Digitized Floor Annunciator: CE Electronics, Inc.

G. Alternate No. PBA-A4: Campus standards for Toilet Accessories

- 1. Base Bid: Provide toilet accessories as specified in Section 10 28 00 "Toilet and Bath Accessories" and as shown on the Drawings.
 - a. Install owner-provided toilet accessories where indicated.
- 2. Alternate: Provide toilet accessories as follows:
 - a. Sanitary Napkin Disposal: Bobrick Contura Series

- 1) Surface mount
- 2) Model: B-270
- b. Sanitary Napkin Dispenser: Bobrick Trim Line Series
 - 1) Surface mount
 - 2) Model: B2800
 - 3) Finish: Stainless Steel, satin
- c. Install owner-provided toilet accessories where indicated.

H. Alternate No. PBA-I1: Campus standards for Floor Sealer and Finish

- 1. Base Bid: Provide sealers as required for durable flooring finishes from acceptable manufacturers specified in Division 09.
- 2. Alternate: Provide flooring finish and sealer as follows:
 - a. Flooring Sealer: Plaza Plus Floor Sealer
 - b. Flooring Finish: Finishes by Diversey Global selected from the following:
 - 1) Vectra High Performance Floor Finish
 - 2) Aquaria Floor Finish

I. Alternate No. PBA-M1: Campus standards for Metering of Mechanical Utilities

- 1. Base Bid: Provide utility meters meeting the requirements of Division 22 and Division 23.
- 2. Alternate: Provide specified meters as follows:
 - a. Condensate: Cadillac CMAG magnetic flowmeter
 - b. Steam: Accelabar
 - c. Chilled Water: Flexim Flexus F721 Energy Ultrasonic Flowmeter
 - d. City Water: Neptune Truflo

J. Alternate No. PBA-M2: Campus standards for HVAC Controls – Johnson Controls, Inc

- 1. Base Bid: Provide controls meeting the requirements of Division 23.
- 2. Alternate: Provide controls from Johnson Controls, Inc.

K. Alternate No. PBA-M3: Campus standards for HVAC Controls – Schneider Electric

- 1. Base Bid: Provide controls meeting the requirements of Division 23.
- 2. Alternate: Provide controls from Schneider Electric.

L. Alternate No. PBA-E1: Campus standards for Pedestrian Area Lighting

- 1. Base Bid: Provide pedestrian area lighting meeting the requirements of Section 26 56 00 “Exterior Lighting.”
- 2. Alternate: Provide KIM Archetype LED Series
 - a. Fixture: 1SA/SAR3E35/60L4K/VOLTAGE/DB
 - b. Photocell Receptacle: A-33 (voltage)
 - c. 12’ Pole: KRS12/4120/SAR/SA/DB/US LABEL
 - d. Finish: Anodized aluminum, Dark Bronze
 - e. Pole: Round, steel, non-tapered 7”-8.5” slotted bolt circle

M. Alternate No. PBA-E2: Campus standards for Street and Parking Lot Area Lighting

1. Base Bid: Provide pedestrian area lighting meeting the requirements of Section 26 56 00 "Exterior Lighting."
2. Alternate: Provide KIM Archetype LED Series as follows for single-sided fixtures:
 - a. Fixture: 1A/AR3E35/120L4K/VOLTAGE/DB
 - b. Photocell Receptacle: A-25 (VOLTAGE)
 - c. 30' Standard Pole: LTRA30-8156/AR/A/DB/UL LABEL
 - 1) Shape: Round, Tapered
 - 2) Finish: Anodized aluminum, Dark Bronze.
 - 3) 11" Bolt Circle
 - d. 30' Banner Pole: PTRS30-81120/AR/A/DB/UL LABEL
 - 1) Shape: Round, Steel, Tapered
 - 2) Finish: Dark Bronze.
 - 3) 10.5" Bolt Circle
3. Alternate: Provide KIM Archetype LED Series as follows for double-sided fixtures:
 - a. Fixture: 2B/AR3E35/120L4K/VOLTAGE/DB
 - b. Photocell Receptacle: A-25 (1 required per double assembly)
 - c. 30' Standard Pole : LTRA30-8156/AR/B/DB/UL LABEL
 - 1) Shape: Round, Aluminum, Tapered
 - 2) Finish : Dark Bronze
 - 3) 11" Bolt Circle
 - d. 30' Banner Pole : PTRS30-81120/AR/B/DB/UL LABEL
 - 1) Finish : Dark Bronze
 - 2) Pole : Round, Steel, Tapered
 - 3) 10.5" Bolt Circle

N. Alternate No. PBA-E3: Campus standards for Parking Lot Area Lighting

1. Base Bid: Provide pedestrian area lighting meeting the requirements of Section 26 56 00 "Exterior Lighting."
2. Alternate: Provide KIM Archetype LED Series as follows for single-sided fixtures:
 - 1) Fixture: 1A/AR3E35/120L4K/VOLTAGE/DB
 - 2) Photocell Receptacle: A-25 (VOLTAGE)
 - 3) 35' Standard Pole : LTRA35-8156/AR/A/DB/UL LABEL
 - a) Finish : Dark Bronze
 - b) Pole : Round, Aluminum, Tapered
 - c) 11.5" Bolt Circle
 - 4) 35' Banner Pole : PTRS35-85120/AR/A/DB/UL LABEL
 - a) Finish : Dark Bronze
 - b) Pole : Round, Steel, Tapered
 - c) 11.5" Bolt Circle
3. Alternate: Provide KIM Archetype LED Series as follows for double-sided fixtures:
 - 1) Fixture: 1A/AR3E35/120L4K/VOLTAGE/DB
 - 2) Photocell Receptacle: A-25 (VOLTAGE)
 - 3) 35' Standard Pole : LTRA35-8156/AR/A/DB/UL LABEL
 - a) Finish : Dark Bronze
 - b) Pole : Round, Aluminum, Tapered
 - c) 11.5" Bolt Circle
 - 4) 35' Banner Pole : PTRS35-85120/AR/A/DB/UL LABEL
 - a) Finish : Dark Bronze

- b) Pole : Round, Steel, Tapered
- c) 11.5" Bolt Circle

O. Alternate No. PBA-E4: Campus standards for Metering of Electricity

- 1. Base Bid: Provide utility meters meeting the requirements of Division 26.
- 2. Alternate: Provide Nexus 1262.

P. Alternate No. PBA-FA1: Campus standards for Fire Alarm Systems

- 1. Base Bid: Provide alarm system dialer meeting requirements of Section 28 31 11 "Digital, Addressable Fire-Detection and Alarm System."
- 2. Alternate: Provide alarm system dialer by Firelite; model MS-10UD.

END OF SECTION 01 23 00

SECTION 01 25 00 - 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. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use CSI Form 13.1A. Submit both pages of form, fully executed. Subcontractor may fill-out form but it must be signed by the Construction Manager.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination 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, side-by-side comparison of significant qualities of proposed substitution with those of the Work specified. Include a matrix chart comparing salient physical features, including ASTM standards, etc. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - 1) Do NOT submit unmarked copies of manufacturers literature. All submitted documents should contain Contractor's highlights of included options and commentary specific to the Work.
 - 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 and 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, Intertek, FM, UL, or other qualified agency approved by the Owner.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution 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 through Construction Manager 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. General: Contractor is advised to consider long-lead items and supply chain issues to eliminate Substitution Requests due to availability.
- B. 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. Requested substitution provides sustainable design characteristics that specified product provided for compliance with project goals.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. 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.
- C. Substitutions for Convenience: Architect will consider requests for substitution if received within 45 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Architect.
 - 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 offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
- b. Requested substitution does not require extensive revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- d. Substitution request is fully documented and properly submitted.
- e. Requested substitution will not adversely affect Contractor's construction schedule.
- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
- g. Requested substitution is compatible with other portions of the Work.
- h. Requested substitution has been coordinated with other portions of the Work.
- i. Requested substitution provides specified warranty.
- j. 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - 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. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions" or Architect's ASI form.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect 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 Architect 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, including fringe benefits. Include wage rate breakdowns for each trade involved.

- 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 acceptable to Owner and Architect.
- 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 Architect.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change, including fringe benefits. Include wage rate breakdowns for each trade involved.
 - 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 Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.
 - 7. Proposal Request Form: Use form acceptable to Owner and Architect.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on a form acceptable to Owner and Architect.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714-2017. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - 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. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

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

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules.
 - 2. Include the following:
 - a. Application for Payment forms with Continuation Sheets
 - b. Submittals Schedule
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 3. Submit the Schedule of Values to Architect through Construction Manager at earliest possible date but no later than 15 days after award of contract and before the submission of the initial Application for Payment.

4. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
 5. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location
 - b. Name of Architect
 - c. Architect's project number
 - d. Contractor's name and address
 - e. Date of submittal
 2. Arrange schedule of values consistent with format of AIA Document G702, Application and Certificate for Payment and Document G703 Continuation Sheets.
 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.
 - 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. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - a. Include separate line items under principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
 5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 6. 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. If specified, include evidence of insurance or bonded warehousing.
7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 8. 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.
 9. 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.
 10. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
 11. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
 12. 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.
 13. 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.
 14. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and Construction Manager and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Final Acceptance, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- C. Additional information required prior to reviewing monthly pay application.
 1. An updated project construction schedule coordinated with pay application
 2. An updated submittals schedule coordinated with pay application

- D. Application for Payment Forms: Use forms acceptable to Architect and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed.
1. Differentiate between items stored on-site and items stored off-site. Only materials stored on-site or in a bonded facility shall be eligible for payment.
 2. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 3. 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.
 4. 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.
- G. Transmittal: Submit 1 original and 4 signed and notarized original copies of each Application for Payment to Architect 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.
- H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is 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 final or full waivers.

3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- I. 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. Products list
 5. **Sustainable Design** action plans; including project materials cost data.
 6. Schedule of unit prices
 7. Submittals Schedule
 8. List of Contractor's staff assignments
 9. List of Contractor's principal consultants
 10. Copies of building permits
 11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work
 12. Initial progress report
 13. Report of preconstruction conference
 14. Certificates of insurance and insurance policies
 15. Performance and payment bonds
 16. Data needed to acquire Owner's insurance
- J. Application for Payment at Final Acceptance: After issuing the Certificate of Final Acceptance, 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.
 2. This application shall reflect Certificates of Partial Final Acceptance issued previously for Owner occupancy of designated portions of the Work.
- K. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims"
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens"
 6. AIA Document G707, "Consent of Surety to Final Payment"
 7. Evidence that claims have been settled.
 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Final Acceptance or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final, liquidated damages settlement statement

10. Final Change Order Adjustments

- a. Final Allowance Adjustments
- b. Deductions for uncorrected Work
- c. Deductions for reinspection payments.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - 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. This 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. Administrative and supervisory personnel
 - 4. Requests for Interpretation (RFIs)
 - 5. Digital project management procedures.
 - 6. Project meetings
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.
- C. Related Sections include the following:
 - 1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
 - 2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Division 01 Section "Commissioning" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.
- C. Weathertight: Erected with the specified air/vapor barrier intact and encircling the building without gaps, holes or missing transitions between building elements which may cause the finished building to perform at less than specified levels.

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 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
1. Post copies of list in project meeting room, in temporary field office, 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. 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.
- B. Additional Procedures:
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors:
 - a. To ensure maximum accessibility for required maintenance, service, and repair, including mechanical and electrical access.
 - b. To ensure components are assembled in the order intended and in a weathertight manner.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors 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. Startup and adjustment of systems
 8. Project closeout activities
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

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. It is the intent of the coordination drawings to identify coordination problems and interferences prior to installation and to establish the layout of this work where exposed in finished spaces for the Architect's review. Drawings shall show the work of all trades covered and shall show clearly that all work can be installed without interference. This effort shall be led by the Contractor.
 2. Time of Coordination of Drawing Preparation: The coordination drawings shall be prepared, submitted and accepted before any sleeves or inserts are set, any floor openings are core drilled, or any mechanical or electrical equipment or bases or related work is fabricated or installed. The completion of the coordination drawings by each trade will be a prerequisite for any progress payment for any material or equipment delivered or for any work by these trades. The preparation of coordination drawings acceptable to the Architect is a contract requirement, the cost of which is included in the contract price. The cost of coordination drawings shall be included as a separate line item in the Schedule of Values.
 3. 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 by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
- c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
- d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
- e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
- f. Indicate required installation sequences.
- g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

- 1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
- 2. Plenum Space: Indicate 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, switch board, 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.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: 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: Develop and incorporate coordination drawing files into BIM established for Project.
 - a. 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, upon request, furnish Contractor with 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 <Insert name and version of digital data software program and operating system>.
 - c. Contractor and Subcontractors shall execute a data licensing agreement in the form of Architect's "Agreement For Delivery Of Instruments Of Service In Electronic Form".

1.7 BUILDING ENCLOSURE COORDINATION DRAWINGS

- A. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
1. Indicate functional and spatial relationships of components of building enclosure systems.
 2. Indicate required installation sequences.
- B. Development of Building Enclosure Coordination Drawings
1. The Contractor and the Roofing, Fenestration, Expansion Joint, Building Facade, Insulation, Air/Vapor Barrier, Sheathing and any other involved subcontractors are each required to participate in the creation and updating of building enclosure coordination

drawings. The purpose of the coordination drawings is to preplan the installation of air/vapor barrier, flashings, expansion/control joints, penetrations, ETAs and any other involved subcontractors in relation to the existing and new facility and its structure, framing, sheathing, fenestration, skin, etc. It is the intent of these coordination drawings to identify coordination problems and proper installation sequences prior to erection and to establish the layout of this work for the Architect's and Owner's Commissioning Agent's review. Drawings shall show the work of all trades covered (including both existing and new), shall show clearly in both plan and section that all work can be installed in a weathertight manner without exception. This effort shall be led by the Contractor.

2. Time of Coordination of Drawing Preparation: The coordination drawings shall be prepared, submitted and accepted before any sheathing or roofing materials are installed. The completion of the coordination drawings will be a prerequisite for any progress payment for any material or equipment delivered or for any work by these trades. The preparation of coordination drawings acceptable to the Architect is a contract requirement, the cost of which is included in the contract price. The cost of building enclosure coordination drawings shall be included as a separate line item in the Schedule of Values.
3. Procedure
 - a. The Contractor shall produce drawings at a scale which is acceptable to the Architect, showing constraints such as structural, substrate information, adjacent materials, flashings, sealants, and sequencing requirements that are coordinated between the affected trades and ready for execution in the field. These shall be used as the coordination drawing base.
 - b. The Contractor will then hold a meeting with all involved subcontractors in attendance to resolve any conflicts or problems. After the coordination drawings are reviewed and any conflicts resolved, the originals shall be signed by the Contractor and each of the involved subcontractors. Any non-resolvable conflicts shall be brought to the attention of the Architect.
 - c. The Contractor shall then make copies and submit the coordination drawings to the Architect and Owner's Commissioning Agent, as record drawings. He shall also transmit copies to the above subcontractors.
 - d. The Contractor shall retain the drawings to be used in preparing the field mockup, the sequenced construction of the building, the third party field testing and the preparation of record documents.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: 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: Develop and incorporate coordination drawing files into BIM established for Project.
 - a. 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, upon request, furnish Contractor 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 <Insert name and version of digital data software program and operating system>.
- c. Contractor shall execute a data licensing agreement in the form of Architect's "Agreement For Delivery Of Instruments Of Service In Electronic Form".

1.8 WORK INSTALLED WITHOUT PRIOR APPROVAL

- A. Any work fabricated or installed prior to the signing of coordination drawings shall be at the subcontractor's risk. Subsequent relocations or reinstallation required to avoid interferences or to correct non-weathertight conditions shall be made without additional expense to the Owner.
 1. If interference develops, the Contractor shall recommend (subject to Architect's review and acceptance) which work shall be relocated, regardless of which was installed first.
 2. Building Envelope issues shall be resolved by the Contractor, Owners Commissioning Agent and Architect.

1.9 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.
- B. Supervision: The Contractor shall employ a competent superintendent and necessary assistants, acceptable to the Owner, who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.
- C. This Project will require the use of full time supervision for the performance of the Work.
 1. The Contractor is required to have a superintendent present at the site of the Project at all times when performance of the Work is actively underway regardless of the day or shift. During these times the superintendent will not be assigned to any other project and will not perform any trade work on the Project. Consistent with the foregoing as well as for superintendent's personal reasons, at those times when the superintendent is taken away from the site of the Project, a replacement superintendent suitable to the Owner shall be assigned to the Project.

1.10 REQUESTS FOR INTERPRETATION (RFIs)

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

- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name
 2. Project number.
 3. Date
 4. Name of Contractor
 5. Name of Architect
 6. RFI number, numbered sequentially
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate
 9. Drawing number and detail references, as appropriate
 10. Field dimensions and conditions, as appropriate
 11. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI
 12. Contractor's signature
 13. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
- C. RFI Form: Software-generated form with substantially the same content as indicated above.
1. Attachments shall be electronic files in Adobe Acrobat PDF format
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by the Architect after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals
 - b. Requests for approval of substitutions
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents
 - e. Requests for adjustments in the Contract Time or the Contract Sum
 - f. Requests for interpretation of Architect's actions on submittals
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "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. Software log with not less than 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.

1.11 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Upon request, 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.
 3. Digital Drawing Software Program: Contract Drawings are available in <Insert name and version of digital drawing software program and operating system>.
 4. Contractor shall execute a data licensing agreement in the form of Architect's "Agreement For Delivery Of Instruments Of Service In Electronic Form".
 - 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 Architect's "Agreement For Delivery Of Instruments Of Service In Electronic Form".
- B. Web-Based Project Software: Use Construction Manager's web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project software site includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.

- d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
- 2. Provide up to seven web-based Project software user licenses for use of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and Architect's consultants. Provide eight hours of software training at Owner'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.
 - 4. Provide **[one of]**the following web-based Project software packages under their current published licensing agreements:
 - a. Autodesk; Construction Cloud (ACC).
 - b. Corecon Technologies, Inc.
 - c. Meridian Systems; Prolog.
 - d. Newforma, Inc.
 - e. Procore Technologies, Inc.
 - f. Viewpoint, Inc.; Viewpoint for Project Collaboration.
- 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.

1.12 PROJECT MEETINGS

- A. General: Construction Manager shall be responsible to preside at 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, Construction Manager, and Architect, within three days of the meeting.
4. Contractor shall make physical arrangements for meetings.
5. Representatives of contractors, subcontractors and suppliers invited to attend meetings shall be qualified and authorized to act on behalf of the entity each represents.

B. Preconstruction “Kickoff” Meeting

1. Architect will schedule and administer preconstruction meeting in conjunction with the Owner and Contractor. The Architect will prepare the meeting agenda and distribute. The Architect will preside at the meeting and shall record and distribute the minutes.
2. Preconstruction Meeting Agenda:
 - a. Discuss items of significance that could affect progress, including the following:
 - 1) Review of projected Construction Schedule.
 - 2) Review project Phasing Requirements.
 - 3) Review critical work sequencing and long-lead items
 - 4) Requirements for Receipt of the Submittal Schedule
 - 5) Procedures for receipt and review of Submittals
 - 6) Procedures for receipt and review of RFIs
 - b. Discuss procedures for the processing of the following:
 - 1) Distribution of the Contract Documents.
 - 2) Procedures for processing Applications for Payment
 - 3) Procedures for processing field decisions and Change Orders
 - 4) Procedures for processing Sustainable Design requirements
 - 5) Procedures for disruptions and shutdowns.
 - 6) Maintenance and Preparation of Record Documents
 - 7) Procedures for moisture and mold control.
 - 8) Procedures for testing and inspecting
 - 9) Designation of key decision making personnel and their responsibilities.
 - 10) Lines of communications.
 - 11) List of major subcontractors and suppliers
 - 12) Submission of insurance certificates to Owner.
 - 13) Procedures for Photographic Records and Distribution.
 - 14) Submittal procedures.
 - c. Discuss Construction Facilities and Operations
 - 1) Use of the premises and existing building
 - 2) Owner's occupancy requirements
 - 3) Responsibility for temporary facilities and controls
 - 4) Use of web-based Project software.
 - 5) Work restrictions
 - 6) Working hours.
 - 7) Temporary utilities
 - 8) Security

- 9) Contractor office, laydown and storage areas
 - 10) Equipment deliveries and priorities
 - 11) Construction waste management and recycling
 - 12) Safety and first aid procedures
 - 13) Contractor parking availability
 - 14) Progress cleaning and housekeeping procedures
3. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and their consultants; assigned SCO Monitor; Contractor and its superintendent and sustainable design coordinator; 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.
 4. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:
 - a. General requirements for sustainable design-related procurement and documentation.
 - b. Project closeout requirements and sustainable design certification procedures.
 - c. Role of sustainable design coordinator.
 - d. Construction waste management.
 - e. Construction operations and sustainable design requirements and restrictions.
 5. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents
 - b. Options
 - c. Related RFIs
 - d. Related Change Orders
 - e. Purchases
 - f. Deliveries
 - g. Submittals
 - h. Sustainable design requirements.
 - i. Review of mockups
 - j. Possible conflicts
 - k. Compatibility problems
 - l. Time schedules
 - m. Weather limitations
 - n. Manufacturer's written recommendations
 - o. Warranty requirements
 - p. Compatibility of materials

- q. Acceptability of substrates
 - r. Temporary facilities and controls
 - s. Space and access limitations
 - t. Regulations of authorities having jurisdiction
 - u. Testing and inspecting requirements
 - v. Installation procedures
 - w. Coordination with other work
 - x. Required performance results
 - y. Protection of adjacent work
 - z. 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 parties who should have been present.
 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. Progress (OAC) Meetings: Contractor will conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - a. SCO Monitor: At least one Progress Meeting per month shall be attended by the assigned SCO Monitor.
 2. 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) Review, approve of minutes of previous meeting
 - 2) Review of unsettled matters
 - 3) Problems which impede Construction Schedule
 - 4) Pending changes and substitutions
 - 5) Review proposed changes for

- a) Effect on Construction Schedule and on completion date
 - b) Effect on other contracts of the Project
- 6) Field observations, problems, conflicts
 - 7) Sustainable design requirements.
 - 8) Review of work progress since previous meeting
 - 9) Contractor's statement of corrective measures and procedures to regain projected schedule
 - 10) Revisions to Construction Schedule
 - 11) Progress, schedule, during succeeding work period
 - 12) Coordination of schedules
 - 13) Maintenance of quality standards
 - 14) Other business
 - 15) Interface requirements
 - 16) Sequence of operations
 - 17) Status of submittals
 - 18) Deliveries
 - 19) Off-site fabrication
 - 20) Access
 - 21) Site utilization
 - 22) Temporary facilities and controls
 - 23) Work hours
 - 24) Hazards and risks
 - 25) Progress cleaning
 - 26) Quality and work standards
 - 27) Status of correction of deficient items
 - 28) Field observations
 - 29) RFIs
 - 30) Status of proposal requests
 - 31) Pending changes
 - 32) Status of Change Orders
 - 33) Pending claims and disputes
 - 34) Documentation of information for payment requests
3. Minutes: Contractor will record and distribute the meeting minutes to the Owner, Architect, all additional designates and all attendees.
- a. Record and distribute meeting minutes within 48 hours of each meeting.
 - b. 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.
- E. Project Closeout Conference: Construction Manager 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 Final Acceptance.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and their consultants; assigned SCO Monitor; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall

- attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Final Acceptance and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - f. Requirements for preparing operations and maintenance data.
 - g. Requirements for delivery of material samples, attic stock, and spare parts.
 - h. Requirements for demonstration and training.
 - i. Preparation of Contractor's punch list.
 - j. Procedures for processing Applications for Payment at Final Acceptance and for final payment.
 - k. Submittal procedures.
 - l. Owner's partial occupancy requirements.
 - m. Installation of Owner's furniture, fixtures, and equipment.
 - n. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - 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. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary (Start-up) Construction Schedule
2. Contractor's Construction Schedule
3. Submittals Schedule
4. Daily construction reports
5. Material location reports
6. Field condition reports
7. Special reports

- B. Related Sections include the following:

1. Division 01 Section "Payment Procedures" for submitting the Schedule of Values
2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes
3. Division 01 Section "Photographic Documentation" for submitting construction photographs
4. Division 01 Section "Submittal Procedures" for submitting schedules and reports
5. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections

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 activities are activities on the critical path. They 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. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.

- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. 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.
- G. Fagnets: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- H. Major Area: A story of construction, a separate building, or a similar significant construction element.
- I. Milestone: A key or critical point in time for reference or measurement.
- J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For scheduling consultant.
- B. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF file.
- C. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal
 - 2. Specification Section number and title
 - 3. Submittal category (action or informational)
 - 4. Name of subcontractor
 - 5. Description of the Work covered

6. Scheduled date for Architect's final release or approval
- D. Preliminary Construction Schedule: Submit two opaque copies.
 1. Submittal of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.
 - E. Preliminary Network Diagram: Submit two opaque copies, large enough to show entire network for entire construction period. Show logic ties for activities.
 - F. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.
 1. Submit an electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
 - G. CPM Reports: Concurrent with CPM schedule, submit three copies of each of the following computer-generated 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 all 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 all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work or the Notice to Proceed, whichever occurs first, until most recent Application for Payment.
 - H. Construction Schedule Updating Reports: Submit with Applications for Payment.
 - I. Daily Construction Reports: Submit two copies at weekly intervals.
 - J. Material Location Reports: Submit two copies at weekly intervals.
 - K. Field Condition Reports: Submit two copies at time of discovery of differing conditions.
 - L. Special Reports: Submit two Insert number copies at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "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, interim milestones and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.
9. Review and finalize list of construction activities to be included in schedule.
10. Review submittal requirements and procedures.
11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 SUBMITTAL REGISTER

- A. Preparation: Submit a Submittal Register listing all submittals required by the Contract Documents, arranged in CSI specification section order, in matrix format similar to the following example:

SECTION 013300.01 - SUBMITTAL REGISTER

SECTION	ACTION SUBMITTALS										INFORMATION SUBMITTALS																				
	Product Data	LEED Submittals	Shop Drawings	Samples	Vendor Anchor Analysis	Product Schedule	Delegated-Design Submittal	Warranty	Material List	Qualification Data	Source Quality Control Reports	Proposed Protection Measures	Inventory	Photos or Video	Statement of Refrigerant Recover	Product/Material Certificates	Mix Designs / Design Data	Welding Certificates	Product/Material Test Reports	Quality Control Test Reports	Field Test Reports	Statement of Compressive Strength	Cold/Hot Weather Procedures	Certification Letter	Operation and Maintenance Data	Energy Performance Certificate	Coordination Drawings	Inspection and Operating Permits	Keys	Research/Evaluation Reports	Slip-Resistance
015639 - Temporary Tree Protection	✓	✓				✓																									
024116 - Structure Demolition	✓	✓																													
033000 - Cast-In-Place Concrete	✓	✓	✓	✓	✓																										
042000 - Unit Masonry	✓	✓	✓	✓	✓																										
044700 - Exterior Stone Cladding	✓	✓	✓	✓	✓																										

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
1. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- C. Time Frame: Extend schedule from date established for commencement of the Work or the Notice to Proceed, whichever occurs first to date of Final Acceptance.
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.
- D. Activities: Treat each story (floor) or separate area as a separate numbered activity for each principal 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. Procurement Activities: Include procurement process activities for the following long lead 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. Mechanical equipment
 - b. Electrical equipment

3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 4. Startup and Testing Time: Include not less than 15 days for startup and testing.
 5. Commissioning Time: Include no fewer than 15 days for commissioning.
 6. Final Acceptance: Indicate completion in advance of date established for Final Acceptance, and allow time for Architect's administrative procedures necessary for certification of Final Acceptance.
- E. 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 Division 01 Section "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 Division 01 Section "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 occupancy before Final Acceptance
 - 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.

1. 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 Acceptance

- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Final Acceptance, and Final Completion.
 1. Temporary enclosure and space conditioning.

- G. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
 1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
 2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 3. Each activity cost shall reflect an accurate value subject to approval by Architect.
 4. Total cost assigned to activities shall equal the total Contract Sum.

- H. 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.

- I. 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.

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

2.4 PRELIMINARY CONSTRUCTION SCHEDULE

- A. Gantt (Bar)-Chart Schedule: Submit preliminary horizontal Gantt-chart-type construction schedule within seven days of date established for commencement of the Work or the Notice to Proceed, whichever occurs first.
- 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 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.5 CPM SCHEDULE REQUIREMENTS

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Preliminary Network Diagram: Submit diagram within 14 days of date established for commencement of the Work or the Notice to Proceed, whichever occurs first. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized, 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 30 days after date established for commencement of the Work or the Notice to Proceed, whichever occurs first.
 - 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, regardless of Architect's approval of the schedule.
 - 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 preliminary 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 commissioning
 - 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.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, **sustainable design documentation**, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Architect.

- 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 list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
 - 1. Contractor or subcontractor and the Work or activity
 - 2. Description of activity
 - 3. Principal 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. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.6 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 (refer to special reports)
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 Acceptances authorized

- B. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.7 SPECIAL REPORTS

- A. Reporting Unusual Events: 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, response 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 3 - EXECUTION (Not Used)

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following services:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.
4. Preconstruction video recordings.
5. Periodic construction video recordings.
6. Construction webcam.

- B. Related Requirements:

1. Division 01 Section "Submittal Procedures" for submitting photographic documentation.
2. Division 01 Section "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
3. Division 01 Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
4. Division 02 Section "Structure Demolition" for photographic documentation before building demolition operations commence.
5. Division 02 Section "Selective Demolition" for photographic documentation before selective demolition operations commence.
6. Division 31 Section "Site Clearing" for photographic documentation before site clearing operations commence.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For photographer and Construction Webcam Service Provider.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. Digital Photographs: Submit image files within three days of taking photographs.
 1. Submit photos by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.

2. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.

D. Video Recordings: Submit video recordings within seven days of recording.

1. Submit video recordings by uploading to web-based project software site. Include copy of key plan indicating each video's location and direction.
2. Identification: With each submittal, provide the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

3. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, three-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as corresponding video recording. Include name of Project and date of video recording on each page.

E. Time-Lapse Video: Submit time-lapse sequence video recordings simultaneously with recording.

1. Submit time-lapse sequence video recordings monthly by uploading to web-based project software site.
2. Identification: For each recording, provide the following information on web-based project software site:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect and Construction Manager.
 - d. Name of Contractor.
 - e. Date(s) and time(s) video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

- B. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project.

1.5 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

1.6 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Metadata: Record accurate date and time and GPS location data from camera.
- E. File Names: Name media files with date, Project area and sequential numbering suffix.

1.7 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- D. Preconstruction Photographs: Before commencement of demolition, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag construction limits before taking construction photographs.

2. Take a sufficient number of photographs (20 minimum) to show existing conditions adjacent to property before starting the Work.
 3. Take a sufficient number of photographs (20 minimum) of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 4. Take additional photographs as required (20 minimum) to record settlement or cracking of adjacent structures, pavements, and improvements.
- E. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
1. Frequency: Take photographs weekly and submit monthly, coinciding with the cutoff date associated with each Application for Payment.
 2. Vantage Points: Following suggestions by Architect, and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Utility work, including excavation, connections, and backfill.
 - c. Above-grade structural framing.
 - d. Exterior building enclosure.
 - e. Interior Work, through date of Final Acceptance.
- F. Final Completion Construction Photographs: Take 20 color photographs after date of Final Acceptance for submission as project record documents. Architect will inform photographer of desired vantage points.
- G. Additional Photographs: Architect and Owner may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
1. Three days' notice will be given, where feasible.
 2. In emergency situations, take additional photographs within 24 hours of request.
 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Final Acceptance of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

1.8 CONSTRUCTION VIDEO RECORDINGS

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.

- B. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
1. Confirm date and time at beginning and end of recording.
 2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- C. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.
- D. Preconstruction Video Recording: Before starting demolition and excavation, record video recording of Project site and surrounding properties from different vantage points, as directed by Architect.
1. Flag construction limits before recording construction video recordings.
 2. Show existing conditions adjacent to Project site before starting the Work.
 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of demolition.
 4. Show protection efforts by Contractor.
- E. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.
1. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every five minutes, from same vantage point each time, to create a time-lapse sequence of 30 minutes in length as follows:
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Utility work, including excavation, connections, and backfill.
 - c. Above-grade structural framing.
 - d. Exterior building enclosure.
 2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
 3. Vantage Points: Following suggestions by Architect and Contractor, photographer shall select vantage points.

1.9 CONSTRUCTION WEBCAM

- A. Webcam: Provide four fixed-location camera(s) with weatherproof housing, mounted to provide unobstructed view of construction site from location approved by Architect, with the following characteristics:
1. Static view or remotely controllable view with mouse-click user navigation for horizontal pan, vertical tilt, and optical zoom of 500 percent minimum].
 2. Capable of producing minimum 12 megapixel images.
 3. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

- B. Web-Based Interface: Provide online interface to allow viewing of each high-definition digital still image captured and stored during construction, from the Internet.
1. Access Control: Provide password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
 2. Storage: Maintain images on the website for reference during entire construction period, and for not less than 30 days after final completion. Provide sufficient memory on remote server to store all Project images.
 3. Online Interface: Provide website interface with Project and client information and logos; calendar-based navigation interface for selecting images; pan and zoom capability within high-definition images.
 4. Forward and Reverse: Provide capability to browse through images, moving forward and backward in time by individual image and by day.
 5. Slideshow: Provide capability to automatically display current images from sites when there are three or more cameras used.
 6. Time-Lapse: Provide capability for online display of project time-lapse.
 7. Dashboard: Provide capability to view thumbnails of all cameras on one screen.
 8. Weather: Provide corresponding weather data for each image captured.
- C. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until final completion. Provide for service of cameras and related networking devices and software.]

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33

SECTION 01 33 00 - 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 requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Division 01 Section "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
 - 3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Division 01 Section "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
 - 5. Division 01 Section "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
 - 6. Division 01 Section "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
 - 7. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 8. Division 01 Section "Project Record Documents" for submitting record documents and record submittals.
 - 9. Division 01 Section "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 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 responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

- C. Record Submittals: Written and graphic information and physical samples, that do not require Architect's responsive action, provided for record purposes.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.
- E. Days: For the purpose of this Section, days are defined as working days based on a 5-day normal work week, excluding Holidays.
- F. CAD: Computer Aided Design.
- G. BIM: Building Information Modeling.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Submittal Schedule: Submit, as an action submittal, a schedule 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 Construction Manager and additional time for handling and reviewing submittals required by those corrections. Comply with list of submittals and time requirements for scheduled performance of related construction activities.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 - 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action or Informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled date of fabrication.
 - h. Scheduled dates for purchasing.
 - i. Scheduled date of fabrication.
 - j. Scheduled dates for installation.
 - k. Activity or event number.

5. Submit schedule a minimum of 10 days before initial submittal is required.
- B. Architect's Digital Data Files: Electronic copies of CAD Drawings or BIM files of the Contract Drawings will not be provided by Architect for Contractor's use in preparing submittals unless specifically agreed to in the Architect's contract with the Owner. Where provisions for file sharing are contractually stipulated, all procedures, protocols and responsibilities shall be agreed to in writing in advance of distribution of any electronic files.
- C. 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 different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received and shall return the submittal "Not Reviewed".
 5. Each separate section of the Specification Divisions 1 through 48 lists the submittals that are requested and will be accepted for review by the Architect. Submittals not requested specifically will be returned to Contractor without review, or accepted for information only.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. The start 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 20 days for initial review of each submittal.
 - a. Submittals specified in Division 09 and Divisions 13 through 33 shall be subject to sequential review.
 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.

- E. Submittal Media (Paper or Electronic): The submittal media shall be determined and approved prior to the receipt of the first submittal and shall remain consistent through the entire project duration.
- F. Electronic Submittals: When approved by the Owner, the Architect will accept submittals electronically. When electronic submittals are chosen as the preferred method of transmission, all submittals must be transmitted electronically (with the exception of physical samples).
1. Submit electronic submittals via email as PDF electronic files.
 - a. PDF resolution shall be a minimum of 100 dpi but no larger than 300 dpi.
 - b. All aforementioned procedures shall apply including transmittal criteria.
 - c. No submittals shall be accepted directly from any subcontractor.
 - d. Submittals of different trades, subcontractors, specification sections, or non-relevant items shall not be submitted within the same submittal transmittal or electronic submission.
 - e. The Contractor shall transmit all electronic submittals to ESubmittals@EwingCole.com. Other project team members may be copied as appropriate, but primary recipient shall be "ESubmittals"
 - f. Electronic submittals sent to "ESubmittals" shall have the Project name and number clearly identified in the subject line. A transmittal shall be included.
 - g. Drawing numbering system must be strictly adhered to in both the file name and within the PDF title block.
 - h. File sizes exceeding 20MB shall be transmitted using a large file transfer mechanism compatible with email. EwingCole can provide access to Newforma info exchange for this purpose, if the Contractor does not have a suitable means to do this. EwingCole will not search and download files from project sites. The only exception to this is if the Owner maintains a project site and this requirement is made known to EwingCole contractually at the time of project award. The Contractor must proactively transmit the files to ESubmittals@EwingCole.com. EwingCole will return the reviewed files either marked up electronically (or redlined and scanned) back to the designated address provided by the Contractor through Newforma.
 - i. Submittals/samples requiring finish, color and texture review may be scanned (in color) and sent to "ESubmittals" but one physical sample must be mailed to EwingCole for review.
 - j. Include the following EwingCole review stamp on each individual pdf of all electronic submittals:

SUBMITTAL ACTION	
SUBMISSION	<input type="checkbox"/> FIRST <input type="checkbox"/> SECOND <input type="checkbox"/> THIRD
<input type="checkbox"/>	REVIEWED
<input type="checkbox"/>	REVIEWED AS NOTED
<input type="checkbox"/>	REVIEWED AS NOTED RESUBMIT
<input type="checkbox"/>	REJECTED
<input type="checkbox"/>	RESUBMIT
<input type="checkbox"/>	SEE TRANSMITTAL FOR INSTRUCTIONS
<p>This submittal has been reviewed only for conformance with the design concept of the Project and compliance with the information given in the Contract Documents.</p> <p>It is the Contractor's contractual duty to review and act upon submittals, prior to their submission to verify that all requirements of the Contract Documents have been met or if they have not been met, to notify the Architect in writing. By the submission of this submittal to the Architect, it is assumed the Contractor has fulfilled these contractual duties. Review of this submittal by Architect does not relieve the Contractor of the duty to meet the requirements of the Contract Documents and the applicable building codes.</p> <p>Any comments noted or corrections requested are for clarification of the general character of the work. Correctness of details, measurements, quantities, conformity with Contract Documents, techniques of construction and coordination with other trades shall remain the complete responsibility of the General/Prime Contractor.</p>	
BY: _____	DATE: _____
<p>EwingCole Philadelphia * Charlotte * Irvine New York * Pittsburgh * Raleigh Architects Engineers Interior Designers Planners</p>	

2. 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.
3. Name file with submittal number and unique identifier as follows:

FORMAT:

- **042000_001.1_Face Brick_Product Data**
- “**042000**” shall be the appropriate specification section for the submittal.
- “**001**” shall be the submission tracking number (not related to a specific category ie. Product data, Warranty, etc.)
- “**.1**” shall indicate the initial submittal.
- “**Face Brick**” shall be the item submitted.
- “**Product Data**” shall be the type of submittal.

Examples:

042000_001.1_Face Brick_Product Data
042000_002.1_Mortar and Grout_Product Data
042000_003.1_Embedded Flashing_Warranty
042000_004.1_Embedded Flashing_Shop Drawings
042000_005.1_Concrete Masonry Units_Calculations

- Subsequent Submissions of the same item (.2), (.3), etc.:
042000_002.2_Mortar and Grout_Product Data

FORMAT:

- **265100_001.1_Emergency Lighting Units_Product Data**
- “**265100**” shall be the appropriate specification section for the submittal.
- “**001**” shall be the submission tracking number (not related to a specific category ie. Product data, Warranty, etc.)
- “**.1**” shall indicate the initial submittal.
- “**Emergency Lighting Units**” shall be the item submitted.
- “**Product Data**” shall be the type of submittal.

Examples:

265100_001.1_Interior Lighting Fixture L1_Product Data
 265100_002.1_Emergency Lighting Units_Product Data
 265100_003.1_Emergency Lighting Units_Warranty
 265100_004.1_Lighting Fixture Supports_Shop Drawings
 265100_005.1_Emergency Lighting Units_Calculations

- Subsequent Submissions of the same item (.2), (.3), etc.:
265100_002.2_Emergency Lighting Units_Product Data

4. Include file name on cover sheet of submittal.

G. 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. Cloud, bubble, or otherwise highlight and identify all revisions on the drawings. Submittals which do not identify changes and revisions will be returned as “Not Reviewed”. Do not renumber submittal documents which have been previously submitted for review except to modify the revision number. Drawings that have been renumbered will be rejected and returned. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. 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.

I. 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 Construction Manager's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals (Action, Informational or Record) are indicated in individual trade Specification Sections.
- B. 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 not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing 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 or concurrent with Samples.
- C. Design Data for Delegated Design Elements: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned "Not Reviewed".
- D. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit digitally signed PDF

electronic file and 3 paper copies of a Certification Letter from the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
 2. Statement that the Professional Engineer is fully experienced in the type of design being performed.
 3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
 4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
 5. Statement that the Professional Engineer will submit an additional signed and sealed letter after construction of the delegated design element is complete, stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.
- E. 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
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. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
 3. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
 - a. Prepare Shop Drawings in the following format: digital data software program, version, and operating system approved by Construction Manager.
 - b. Refer to Section 01 31 00 "Project Management and Coordination" for requirements for coordination drawings.
- F. Field Work Shop Drawings: Prepare location specific information illustrating the proposed field modification of an element. Submit proposed modification and received written approval prior to performing the field modification. Field work shop drawings shall clearly reference the latest related shop drawings. For additional requirements, refer to "Shop Drawings" above.

- G. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - 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. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. 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.
 6. 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 one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected. Final approval to be authorized with samples submitted with Samples for Verification.
 7. 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, unless otherwise noted in the individual technical sections. Architect will retain two Sample sets; remainder will be returned.

- 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.
- H. 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.
- I. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."
- J. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- K. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- L. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- M. 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.
- N. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- O. Installer Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the Installer, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- P. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

- Q. Product Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying that product complies with requirements in the Contract Documents. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- R. Material Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying that material complies with requirements in the Contract Documents. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- S. 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.
- T. 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.
- U. 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:
1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- V. 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.
- W. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- X. 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. Field tests include all tests that are performed by the contractor in conjunction with systems installations. Unless noted in the individual specification section, these field tests do not include testing and inspection reports provided by the Owner's independent testing and inspection agency.
- Y. Final Certification Letter from Delegated-Design Professional: After construction of the delegated design element is complete, submit digitally signed PDF electronic file and three paper

copies of a Certification Letter from the responsible design professional stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.

- Z. Record Submittals: Refer to Division 01 Section "Project Record Documents" for requirements.
- AA. Closeout Documents and Maintenance Material Documents: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

2.2 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. BIM Incorporation: Incorporate delegated-design drawing and data files into BIM established for Project.
 - 1. Prepare delegated-design drawings in the following format: Digital software as approved by Construction Manager.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Documents: See requirements in Division 01 Section "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, [Architect's Project No.](#), submittal number, Specification Section title and number, 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. [Regardless of language on Contractor's stamp \(reviewed, checked, etc.\), submittals by Contractor for Architect's review will be considered "Approved" by Contractor.](#)
- D. Determine and verify:
 - 1. Field measurements.
 - 2. Field construction criteria.
 - 3. Catalog numbers and similar data.

- E. Coordinate each submittal with other submittals as well as with requirements of the Work and Contract Documents.
- F. Advise priority requirements, if any, for review of submittals.
 - 1. If submittals are made in large quantities from any one subcontractor or a large quantity of drawings from several subcontractors all at one time, the normal time required by the Architect for review cannot be expected to suffice; Contractor shall, in such instances, indicate the priority and/or sequence of review desired.
 - 2. If no priority requirement is indicated, Architect will review submittals in the order received.
- G. Identify all material list items and submittals by the title of the specification section, paragraph, and page from which they are specified.
- H. Contractor and/or manufacturer Shall Not use the color red when marking their notations on the submittal. Green shall be used to distinguish the Contractor's comments.

3.2 ARCHITECT'S RESPONSE

- A. General: Architect will not review submittals that do not bear Construction Manager's or Contractor's approval stamp and **may** return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

Submittal Code Letter	Description
A	Reviewed: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents. Architect will not include any comments. Fabrication can proceed. No further submissions are required prior to the record submission (when applicable).
B	Reviewed As Noted: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents, except for corrections indicated. Fabrication can proceed on the basis that Contractor is fully responsible for incorporating indicated corrections into the work. No further submissions are required prior to the record submission (when applicable).
C	Reviewed as Noted and Resubmit: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents, except for corrections indicated. Shop fabrication can proceed on the basis that Contractor is fully responsible for incorporating indicated corrections into the work. Resubmission is required prior to commencement of erection, installation or placement for confirmation of corrections noted.
D	Rejected: Procedural or technical nonconformity with the design concept and the information given in the Contract Documents. Fabrication should NOT proceed pending further review.
E	Resubmit: Indicates that corrections of a major nature are required, should be incorporated in the submittal, and the submittals shall be resubmitted for

Architect's further review. Fabrication should NOT proceed pending further review.

- F See Transmittal for Instructions: Refer to the Response Transmittal for specific direction.
- C. Informational Submittals: Architect will receive Informational Submittals and respond “Accepted for Information” or “Not Accepted for Information”. Transmittals only will be returned to the Contractor indicating status of acceptance and will include any comments or reasons for not accepting. Architect will forward each submittal to appropriate party.
- D. Record Submittals: Only where specifically required in the individual trade Specification Sections, Architect will receive Record Submittals and respond “Accepted for Record” or “Not Accepted for Record”. Transmittals only will be returned to the Contractor indicating status of acceptance and will include any comments or reasons for not accepting.
- E. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- F. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- G. Submittals not required by the Contract Documents may be returned by the Architect without action or accepted for information only.

END OF SECTION 01 33 00

SECTION 01 40 00 - 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. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect or Owner, Commissioning Authority, 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 Sections include the following:
 - 1. Division 01 Sections "Special Inspections" and "Statement of Special Inspections" for Code-Required Test and Inspection Requirements and Statement of Special Inspections Forms.
 - 2. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 3. Division 01 Section "Execution" for repair and restoration of construction disturbed by testing and inspecting activities.

1.3 DEFINITIONS

- A. 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.
- B. 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. Services do not include contract enforcement activities performed by Architect.

- C. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- D. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. 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, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. 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. If individual sections specify more than 5 years, the specified number of years shall take precedence.

1.4 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting

requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. **Where two or more quantities or quality levels of the same Work are indicated, provide the most stringent.** The actual installation **must** comply with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits **as determined by the Architect.** To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

- A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. 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.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Description of test and inspection.
 - 3. Identification of applicable standards.
 - 4. Identification of test and inspection methods.
 - 5. Number of tests and inspections required.
 - 6. Time schedule or time span for tests and inspections.
 - 7. Entity responsible for performing tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- E. Reports: Prepare and submit certified written reports and documents as specified.
- F. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 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, and telephone number 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 inspecting.
 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, and telephone number 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, or 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, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, 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.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- 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, 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.
 - 1. Authorized Installer: A firm which has been authorized by a manufacturer to appropriately install their product.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirement for specialists shall not supersede building codes and regulations governing the Work.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. 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.

- 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:
1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project unless specifically noted otherwise.
 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, 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 General: 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 in location and of 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. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Mockups shall be erected in stages in sufficient steps as required to clearly demonstrate construction techniques and sequence from initial materials to finishes. All constructability issues shall be resolved to the satisfaction of the Architect and Contractor during mockup erection.
 6. The Contractor shall not release materials for purchase or fabrication until the mockup has been reviewed and approved by the Owner and Architect. Materials released prior to approval by both are done so at the Contractors own risk.
 7. Obtain Architect'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.
 8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 9. Demolish and remove mockups when directed, unless otherwise indicated.

- L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.10 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility in Division 01 Section "Testing Laboratory Services", 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 inspecting they are engaged to perform.
 - 2. Payment for these services will be made from testing and inspecting 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 and the contract sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. 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.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting 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 inspecting 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. 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 Division 01 Section "Submittal Procedures."
- D. 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.

- E. 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.
- F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Contractor Services: Cooperate with agencies 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 inspecting. 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 inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
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. Submit schedule within 15 days of date established for commencement of the Work/the Notice to Proceed.
1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in Statement of Special Inspections attached to Division 01 Section "Testing Laboratory Services", and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Final Acceptance, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. 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 modifications as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, 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, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
 2. Comply with the Contract Document requirements for Division 01 Section "Execution".

- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 41 00 - SPECIAL INSPECTIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SUMMARY

- A. Special Inspections and Structural Testing shall be in accordance with Chapter 17 of the North Carolina State Building Code, 2018 Edition.
- B. Special Inspections are a quality assurance program intended to ensure that the work is performed in accordance with the Contract Documents.
- C. This Section is intended to inform the Contractor of the Owner’s quality assurance program and the extent of the Contractor’s responsibilities. This Section is also intended to notify the Special Inspector, Testing Laboratory, and other Agents of the Special Inspector of their requirements and responsibilities.

1.3 SCHEDULE OF INSPECTIONS AND TESTS

- A. Required inspections and tests are described in the “Statement of Special Inspections” attached at the end of this Section.

1.4 QUALIFICATIONS

- A. The Special Inspector shall be a licensed Professional Engineer or licensed Registered Architect who is approved by the Owner.
- B. The Testing Laboratory and individual technicians shall be approved by the Owner.
- C. The Testing Laboratory shall maintain a full-time licensed Professional Engineer on staff who shall certify the test reports. The Engineer shall be responsible for the training of the testing technicians and shall be responsible for the field and laboratory testing operations.
- D. Special Inspections shall be performed by inspectors who are a licensed Professional Engineer, licensed Registered Architect, Engineer-in-Training or Engineering Intern with an education and background applicable to the work being inspected, except as indicated below:
 - 1. Technicians performing standard tests described by specific ASTM Standards shall have training in the performance of such tests and must be able to demonstrate either by oral or written examination competence for the test to be conducted. They shall be under the supervision of a licensed Professional Engineer or licensed Registered Architect and shall not be permitted to independently evaluate test results.

2. Technicians performing construction field observations shall have training in the review and observation of specific construction materials and must be able to demonstrate either by oral or written examination competence for the test to be conducted. Technicians shall have certifications provided by accredited Professional Organizations within the industry for satisfactory completion of courses or tests demonstrating a thorough understanding of the work. They shall be under the supervision of a licensed Professional Engineer or licensed Registered Architect and shall not be permitted to independently evaluate test results.

1.5 SUBMITTALS

- A. The Special Inspector and Testing Laboratory shall submit to the Architect and Owner, for review, a copy of their qualifications, which shall include the names and qualifications of each of the individual inspections and technicians who will be performing inspections or tests.
- B. The Special Inspector and Testing Laboratory shall disclose any past or present business relationship or potential conflict of interest with the Contractor or any of the Subcontractors whose work will be inspected or tested.

1.6 PAYMENT

- A. The Owner shall engage and pay for the services of the Special Inspector, Agents of the Special Inspector and the Testing Laboratory.
- B. If any materials which require Special Inspections are fabricated in a plant which is not located within 100 miles of the Project, the Contractor shall be responsible for the travel expenses of the Special Inspector or Testing Laboratory.
 1. Expenses shall be adequate to provide same-day round-trip transportation to remote plant.
 2. Expenses shall include travel, lodging and meals.
- C. The Contractor shall be responsible for the cost of any retesting or re-inspections of work which fails to comply with the requirements of the Contract Documents.

1.7 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall cooperate with the Special Inspector and his agents so that the special inspections and testing may be performed without hindrance.
- B. The Contractor shall review the "Statement of Special Inspections" and shall be responsible for coordinating and scheduling inspections and tests. The Contractor shall notify the Special Inspector or Testing Laboratory at least 24 hours in advance of a required inspection or test. Un-inspected work that required inspection may be rejected solely on that basis.
- C. The Contractor shall provide incidental labor and facilities to provide access to the work to be inspected or tested, to obtain and handle samples at the site or at the source of products to be tested and to facilitate tests and inspection, storage and curing of test samples.

Energy costs related to the testing of the smoke removal system shall be responsibility of the Contractor.

- D. The Contractor shall keep at the Project site, the latest set of construction drawings, field sketches, approved and field use shop and erection drawings and specifications for use by the inspectors and testing technicians.
- E. The special inspection program shall in no way relieve the Contractor of his obligation to perform the work in accordance with the requirements of the Contract Documents or form implementing an effective quality control program. All work that is to be subjected to Special Inspections shall first be reviewed by the Contractor's quality control personnel.
- F. The Contractor shall be solely responsible for construction site safety.

1.8 LIMITS ON AUTHORITY

- A. The Special Inspector or Testing Laboratory must not release, revoke, alter, or enlarge on the requirements of the Contract Documents.
- B. The Special Inspector or Testing Laboratory will not have control over the Contractor's means and methods of construction.
- C. The Special Inspector or Testing Laboratory shall not be responsible for construction site safety.
- D. The Special Inspector or Testing Laboratory has no authority to stop the work.

1.9 RECORDS AND REPORTS

- A. Detailed daily reports shall be prepared of each inspection and test and submitted to all interested parties. Reports shall include:
 - 1. Date of test or inspection.
 - 2. Name of inspector or technician.
 - 3. Location of specific areas tested or inspected.
 - 4. Description of test or inspection and results.
 - 5. Applicable ASTM Standard.
 - 6. Weather conditions.
 - 7. Engineer's seal and signature.
- B. The Special Inspector shall submit interim reports to the Owner at the monthly meetings, which includes all inspections and test reports received that week. Copies shall be sent to the Architect, Engineer, SCO and Contractor.
- C. Any discrepancies from the Contract Documents found during a Special Inspection shall be immediately reported to the Contractor. If the discrepancies are not corrected, the Special Inspector shall notify the Owner. Reports shall document all discrepancies identified and the corrective action taken.

- D. The Testing Laboratory shall immediately notify the Architect and Owner by telephone, fax, or email of any test results which fail to comply with the requirements of the Contract Documents.
- E. Reports shall be submitted to the Special Inspector within seven (7) days of the inspection or test. Handwritten reports may be submitted if final typed copies not available.
- F. At the completion of the work requiring special inspections, each inspection agency and testing agency shall provide a statement to the Special Inspector that all work was completed in substantial conformance with the Contract Documents and that all appropriate inspections and tests were performed.

1.10 FINAL REPORT OF SPECIAL INSPECTIONS

- A. The “Final Report of Special Inspections” shall be completed by the Special Inspector and submitted to the Architect and Owner prior to the issuance of a Certificate of Use and Occupancy.
- B. The “Final Report of Special Inspections” will certify that all required inspections have been performed and will itemize any discrepancies that were not corrected or resolved.

1.11 SCHEDULE OF SPECIAL INSPECTION SERVICES

- A. General: See attached schedules.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01 41 00

SECTION 01 41 01 - STATEMENT OF SPECIAL INSPECTIONS

Project: SKA Project number 220445

Location: 1081 Varsity Drive, Raleigh, NC 27606

Owner's Representative: Bob Cwikla

Owner's Address: NC State University
Facilities
Administrative Services III, 369 C
2701 Sullivan Drive
Raleigh, NC 27607

Architect of Record: EwingCole

Structural EOR: SKA Consulting Engineers, Inc.

This Statement of Special Inspections is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the 2018 North Carolina State Building Code. It includes a Schedule of Special Inspection Services applicable to this project as well as the name of the Special Inspector and the identity of other approved agencies intended to be retained for conducting these inspections.

The Special Inspector shall keep records of all inspections and shall furnish inspection reports to the State Construction Office, Structural Engineer and Architect of Record. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the registered design professional in responsible charge, Structural Engineer and Architect of Record. The Special Inspections program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Owner, Structural Engineer and Architect of Record. Interim Report Frequency: Monthly

A Final Report of Special Inspections documenting completion of all required Special Inspections and correction of any discrepancies should be submitted prior to issuance of a Certificate of Use and Occupancy.

Job Site safety and means and methods of construction are solely the responsibility of the Contractor.

Statement of Special Inspections Prepared by (Structural Engineer of Record):

Aaron B. Bopp, PE

(Type or print name)



2024-01-29

Signature

Date

Owner's Authorization

Signature

Date

Signature

Date

Schedule of Special Inspection Services

The following sheets comprise the required schedule of special inspections for this project. The construction divisions which require special inspections for this project are as follows.

- | | |
|---------------------------------------------------------------------|--------------------------------------------------------------|
| <input checked="" type="checkbox"/> Structural Steel | <input type="checkbox"/> Special Foundations |
| <input type="checkbox"/> Cold-Formed Steel Framing | <input type="checkbox"/> Wall Panels/Veneer |
| <input checked="" type="checkbox"/> Cast-in-Place Concrete | <input type="checkbox"/> Sprayed Fire-Resistant Material |
| <input checked="" type="checkbox"/> Masonry | <input type="checkbox"/> Exterior Insulation & Finish System |
| <input type="checkbox"/> Wood Construction | <input type="checkbox"/> Smoke Control |
| <input checked="" type="checkbox"/> Soils | <input type="checkbox"/> Fire Rated Penetrations |
| <input checked="" type="checkbox"/> Retaining Walls in Excess of 5' | |

Inspection Agents	Qualifications	Address
1. Special Inspector	SI	
1. Structural Engineer of Record	SER	Aaron B. Bopp, PE 7900 Triad Center Drive Suite 200 Greensboro, NC 27409
2. Testing Laboratory	ITL	
4. Other	See Qualifications	

Note: The inspection and testing agent shall be engaged by the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the owner, prior to commencing work.

Seismic Design Category: B

Basic Wind Speed: 115 mph

Wind Exposure Category: C

The inspection agent shall submit a report of special inspection to the Special Inspector within four (4) days of performing an inspection or test.

QUALIFICATIONS OF INSPECTORS AND AGENTS OF SPECIAL INSPECTORS

The qualifications of all personnel performing Special Inspection activities are subject to the approval of the Building Official. The credentials of all inspectors shall be provided if requested. The individuals performing a stipulated test or inspection shall have certification or license as indicated below and/or equivalent ICC Certification for the materials, procedures or testing being observed or performed respectively.

The Special Inspector (SI) shall be a licensed Professional Engineer (PE or SE) with a minimum of 3 years of experience as a Special Inspector. The SI shall have experience in the design of structures.

1. SE Structural Engineer: A licensed PE or SE specializing in the design of building structures.
2. Geotechnical Engineer: A licensed PE specializing in soil mechanics and foundations.
3. Structural Engineering Intern: A graduate engineer who has passed the Fundamentals of Engineering examination, with experience in the design of building structures and working under the supervision of a licensed structural PE or SE.
4. Geotechnical Engineering Intern: A graduate engineer who has passed the Fundamentals of Engineering examination, with experience in soil mechanics and foundations and working under the supervision of a licensed geotechnical PE or SE.
5. Geotechnical Technician 1: An experienced technician with National Institute for Certification in Engineering Technologies: Level 2 – Soils certification.
6. Geotechnical Technician 2: An experienced technician with National Institute for Certification in Engineering Technologies: Level 2 – Geotechnical Engineering certification.
7. Concrete Technician 1: An experienced technician with American Concrete Institute – Grade I Concrete Field Testing Technician or Grade I Concrete Laboratory Testing Technician certification.
8. Concrete Technician 2: An experienced technician with American Concrete Institute – Grade II Concrete Laboratory Testing Technician or ICBO Reinforced Concrete Special Inspector certification.
9. SCSI Inspection/Testing Company with fire protection engineering experience, mechanical engineering experience, and certification as air balancers.

Schedule of Special Inspection Services
Structural Steel

Item	Qualifications	Scope
1. Fabricator Certification/Quality Control Procedures	SI SER/SI	<ul style="list-style-type: none"> • Ensure fabricator meets requirements of NCSBC 1704.2.2 • Collect Certificate of Compliance from fabricator at completion of fabrication
1. Material Verification of high strength bolts and washers	SER/SI SER/SI	<ul style="list-style-type: none"> • Periodic verification of markings to conform to ASTM standards specified in the approved construction documents. • Collect manufacturer's certificate of compliance.
2. Inspection of high-strength bolting	SER/SI SER/SI SER/SI	<ul style="list-style-type: none"> • Periodic verification of snug tight joints. • Periodic verification of pretensioned and slip-critical joints using turn-of-nut with matchmarking, twist-off bolts or direct tension indicator methods of installation. • <u>Continuous</u> verification of pretensioned and slip-critical joints using turn-of-nut without matchmarking or calibrated wrench methods of installation.
3. Material verification of structural steel and cold-formed steel deck	SI SI SER/SI	<ul style="list-style-type: none"> • Periodic verification for structural steel. Identifications of markings to conform to AISC 360. • Periodic verification for other steel. Identifications of markings to conform to ASTM standards specified in the approved construction documents. • Collect manufacturer's certified test reports.
4. Material verification of weld filer materials	SI SER/SI	<ul style="list-style-type: none"> • Periodic verification of materials. Identification markings to conform to AWS specifications in the approved construction documents. • Collect manufacturer's certificate of compliance.
6. Inspection of Welding	SI SI	<ul style="list-style-type: none"> • <u>Continuous</u> or periodic Inspection of welding of structural steel members in accordance with NCSBC Table 1704.3 <ul style="list-style-type: none"> • <u>Continuous</u> monitoring of complete or partial penetration groove welds. • <u>Continuous</u> monitoring of multipass fillet welds. • <u>Continuous</u> monitoring of single pass fillet welds in excess of 5/16". • <u>Continuous</u> monitoring of plug or slot welds. • Periodic monitoring of single pass fillet welds 5/16" or less. • Periodic monitoring of floor or roof deck welds. • <u>Continuous</u> or periodic Inspection of welding of reinforcing steel in accordance with NCSBC Table 1704.3 <ul style="list-style-type: none"> • Periodic verification of weldability of reinforcing steel other than ASTM A 706.

	SER/SI	<ul style="list-style-type: none"> • <u>Continuous</u> monitoring of reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement. • <u>Continuous</u> monitoring of welding of shear reinforcement. • Periodic monitoring of welding of other reinforcement. • Identify use of approved filler material and in accordance with AWS D1.1
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Retaining Walls In Excess of 5' of Retained Fill

Item	Qualifications	Scope
1. Foundation	SI / ITL	<ul style="list-style-type: none"> • Foundation system, including all materials and installation, is adequate for the intended site conditions.
2. Construction Material	SER / SI / ITL	<ul style="list-style-type: none"> • Measurement of the quality of construction materials for conformance with specifications
3. Soil Conditions	SI / ITL	<ul style="list-style-type: none"> • Determination of similarity of actual soil conditions to those anticipated and assumed in design.
4. Backfill	SI / ITL SI / ITL	<ul style="list-style-type: none"> • Examination of the backfill materials for compliance with the plans and specifications. • Examination of drainage systems behind the wall for compliance with the plans and specifications.

Cast-in-Place Concrete

Item	Qualifications	Scope
1. Mix Design/Material Certifications	SER / SI	<ul style="list-style-type: none"> Collect mix designs and verify appropriate mix use during specific installation
2. Reinforcement Installation	SER / SI SI ITL ITL	<ul style="list-style-type: none"> Periodic inspection of reinforcing steel and welded wire fabric Collection of certified mill test reports Inspection of anchor bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased per IBC section 1911.5 or where strength design is used Inspection of anchors and reinforcing steel installed in hardened concrete: verify anchor type, anchor dimensions, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete minimum thickness, anchor embedment and tightening torque
3. Concrete Placement/Monitoring Fresh Concrete, Sampling & prep of test samples	SI / ITL SI / ITL SI / ITL SI / ITL SI / ITL SI / ITL	<ul style="list-style-type: none"> Continuous inspection of cast-in-place concrete placement Continuous monitoring of sampling of fresh concrete, slump test, air content test, temperature of concrete and creation of strength test specimens Continuous inspection of bolts to be installed in concrete prior to and during placement Concrete strength testing and verification of compliance with construction documents Verify use of approved design mix Inspection of concrete placement for proper application techniques
4. Curing & Protection	SI / ITL	<ul style="list-style-type: none"> Periodic inspections of curing techniques
5. Post-Installed Anchors	SI/ITL	<ul style="list-style-type: none"> Verify materials and anchor preparation prior to installation Continuous Observation of installation Periodic Proof testing Verify installing Personnel have been trained for adhesive installation Verify Materials, spacing and location Verify Installation Conditions Verify installation depth and hole preparation. Continuous Inspection of Adhesive and Anchor/Reinforcement installation Verify/Observe Post-installed Torque Continuous monitoring of proof load tests Proof test 5% of adhesive anchors

Soils

Item	Qualifications	Scope
1. Site Preparation	SI	<ul style="list-style-type: none"> Determine that site has been prepared in accordance with the approved soils report
2. Fill Placement	SI	<ul style="list-style-type: none"> Determine that material used and maximum lift thickness comply with approved soils report
3. Density Evaluation	SI / ITL	<ul style="list-style-type: none"> Determine that in-place dry density of the compacted fill complies with approved soils report
4. Retaining Walls over 5 Ft.	SI / ITL SI / ITL SI / ITL SI / ITL SI / ITL	<ul style="list-style-type: none"> Periodically verify materials below foundations are adequate to achieve the design bearing capacity. Verify excavations are extended to proper depth and have reached proper material. Periodically perform classification and testing of controlled fill materials. Continuously verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill Periodically prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly

Schedule of Special Inspection Services
Masonry

Item	Qualifications	Scope
1. Material Certification	SI SI SI	<ul style="list-style-type: none"> Collect mix design for mortar Collect mix design for grout Certificates of Compliance for masonry constituents
2. Mixing of Mortar & Grout	SI	<ul style="list-style-type: none"> Periodic inspection of site prepared mortar Periodic verification of f'm prior to construction except where specifically exempted by the North Carolina State Building Code.
3. Installation of Masonry	SI SER / SI	<ul style="list-style-type: none"> Inspection of construction of mortar joints, prior to beginning masonry construction and during construction Verify size and location of structural elements
4. Reinforcement Installation	SER / SI SER / SI SER / SI	<ul style="list-style-type: none"> Verify location of reinforcement and connections to structure prior to construction Prior to grouting verify size, grade, and placement of reinforcement and connection of masonry to structural frame Verify size and location of structural masonry elements.
5. Grouting Operations	SI	<ul style="list-style-type: none"> Continuous observation of the placement of all grout, conforming cleanliness of grout space placement of the reinforcing connectors.
6. Weather Protection	SI	<ul style="list-style-type: none"> Periodically verify protection techniques for construction of masonry below 40°F and above 90°F
7. Observation of the Evaluation of Masonry Strength	SI / ITL	<ul style="list-style-type: none"> Continuous observation of the preparation of grout specimens, mortar specimens and or prisms.
8. Post-Installed Anchors	SI/ITL	<ul style="list-style-type: none"> Verify materials and anchor preparation prior to installation Continuous Observation of installation Periodic Proof testing Verify installing Personnel have been trained for adhesive installation Verify Materials, spacing and location Verify Installation Conditions Verify installation depth and hole preparation. Continuous Inspection of Adhesive and Anchor/Reinforcement installation Verify/Observe Post-installed Torque Continuous monitoring of proof load tests Proof test 5% of adhesive anchors
9. Self-consolidating Grout	SI	<ul style="list-style-type: none"> Continuous verification of slump flow and VSI as delivered to the site for self-consolidating grout.

AGENT'S FINAL REPORT OF SPECIAL INSPECTIONS

Project Name: NCSU Doak Field Enhancement
SKA Project number 220445

Owner: Bob Cwikla
Owner's Address: NC State University
Facilities
Administrative Services III, 369 C
2701 Sullivan Drive
Raleigh, NC 27607

Building Official: NC State Construction Office

Special Inspector:

Inspection Agent: _____
(Agent Title as listed in Statement of Special Inspections)

(Company Name)

(Company Address)

To the best of my information, knowledge, and belief, the special inspections or testing required for this project and itemized for this Agent in the STATEMENT OF SPECIAL INSPECTIONS submitted for permit have been performed and all discovered discrepancies have been reported and resolved other than the following:

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully Submitted,

(Type or Print Name)

Signature

Date

Seal or Certification

FINAL REPORT OF SPECIAL INSPECTIONS

Project Name: NCSU Doak Field Enhancement
SKA Project number 220445

Owner: Bob Cwikla
Owner's Address: NC State University
Facilities
Administrative Services III, 369 C
2701 Sullivan Drive
Raleigh, NC 27607

Building Official: NC State Construction Office

Designers: EwingCole
801 Central Avenue
Suite C
Charlotte, NC 28204

SKA Consulting Engineers, Inc.
7900 Triad Center Drive, Suite 200
Greensboro, NC 27409
Phone: (336) 855-0993

Special Inspector:

To the best of my information, knowledge, and belief, the special inspections required for this project and itemized in the STATEMENT OF SPECIAL INSPECTIONS submitted for permit have been performed and all discovered discrepancies have been reported and resolved other than the following:

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully Submitted,

Date

Seal

SECTION 01 42 00 - 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": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations, **complete, functioning, and ready for the intended use.**
- 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.
- J. "RFI" – "Request for Interpretation": Contractor's request for clarification of Architect's design intent.

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.
- 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 indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. The information in this list is subject to change and is believed to be accurate and up-to-date as of the date of the Contract Documents.
 - 1. AABC - Associated Air Balance Council; www.aabc.com.
 - 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 - 3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
 - 4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 - 5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
 - 6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 - 7. ABMA - American Boiler Manufacturers Association; www.abma.com.
 - 8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
 - 9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
 - 10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 - 11. AF&PA - American Forest & Paper Association; www.afandpa.org.
 - 12. AGA - American Gas Association; www.aga.org.
 - 13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 - 14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 - 15. AI - Asphalt Institute; www.asphaltinstitute.org.
 - 16. AIA - American Institute of Architects (The); www.aia.org.
 - 17. AISC - American Institute of Steel Construction; www.aisc.org.
 - 18. AISI - American Iron and Steel Institute; www.steel.org.
 - 19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
 - 20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 - 21. ANSI - American National Standards Institute; www.ansi.org.

22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWWA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformance Europeenne; <http://ec.europa.eu/growth/single-market/ce-marking/>.
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csagroup.com.
65. CSA - CSA International; www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.

67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.
89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. ICBO - International Conference of Building Officials; (See ICC).
101. ICC - International Code Council; www.iccsafe.org.
102. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
103. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
104. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
105. IEC - International Electrotechnical Commission; www.iec.ch.
106. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
107. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
108. IESNA - Illuminating Engineering Society of North America; (See IES).
109. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
110. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
111. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
112. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.

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

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

204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
205. WI - Woodwork Institute; www.wicnet.org.
206. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
207. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate and up-to-date as of the date of the Contract Documents.

1. DIN - Deutsches Institut für Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. 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 believed to be accurate and 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.

E. 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. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.

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).
- F. 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. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date 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.cal-iaq.org.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. NCSU / NC State; North Carolina State University; www.ncsu.edu.
 7. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 8. SCO; North Carolina State Construction Office; www.doa.nc.gov/divisions/state-construction-office.
 9. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforests-service.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - 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. Division 01 Section "Summary" for work restrictions and limitations on utility interruptions.
 - 2. Divisions 02 through 49 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
 - 3. Division 31 Section "Dewatering" for disposal of ground water at Project site.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Contractor will pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Contractor will pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Contractor will 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. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- E. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Show compliance with NC State University Design and Construction Guidelines, Division 01 Contractor Safety Requirements. Indicate Contractor personnel responsible for management of fire-prevention program.
- F. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
 - 1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 - 2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 - 3. 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.

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.

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.
- B. The Contractor's request for use of docks, corridors, elevators, stairs and other spaces outside of the project limit shall be limited to use on an as-needed basis and such use shall be approved in advance by the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top rails.
- B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide galvanized-steel bases for supporting posts.
- C. 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.
- D. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E84 and passing NFPA 701 Test Method 2.
- E. 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, General: 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, 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 less than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot-square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
 - 7. High-speed Internet Service: compatible with Architect's, Owner's and Contractor's systems.
- 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, electric coil unit 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 Units: Listed and labeled for power source, 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 Division 01 Section "Closeout Procedures".

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.

- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash 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. 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.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. 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.
 - 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- I. 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.
 - 2. Install lighting for Project identification sign.
- J. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.

1. Provide additional telephone lines for the following:
 - a. Provide a dedicated telephone line for each facsimile machine in each field office.
 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Construction Manager's home office.
 - g. Engineers' offices.
 - h. Owner's office.
 - i. Principal subcontractors' field and home offices.
 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- K. Electronic Communication Service: Provide internet and printing services in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications.
1. Network Connectivity: Gigabit.
 2. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
 3. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 100 Mbps upload and 100 Mbps download speeds at each computer.
 4. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.

3.4 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Maintain support facilities until Architect schedules Final Acceptance inspection. Remove before Final Acceptance. Personnel remaining after Final Acceptance 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 within construction limits indicated on Drawings.
1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Comply with requirements of University Transportation and City of Raleigh Department of Transportation.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
 3. Traffic Signals and Signs

- a. Provide and operate traffic control and directional signals required to direct and maintain an orderly flow of traffic in all areas under Contractor's control, or affected by contractor's operations.
 - b. Provide traffic control and directional signs, mounted on barricades or standard posts:
 - 1) At each change of direction of a roadway and at each crossroads.
 - 2) At detours.
 - 3) At parking areas.
4. Flagmen
- a. Provide qualified and suitably equipped flagmen when construction operations encroach on traffic lanes, as required for regulation of traffic.
5. Construction Parking Control
- a. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
 - b. Monitor parking of construction personnel's private vehicles:
 - 1) Maintain free vehicular access to and through parking areas.
 - 2) Prohibit parking on or adjacent to access roads, or in nondesignated areas.
- D. Parking: Provide temporary parking areas for construction personnel.
- 1. Parking shall be coordinated with NC State University Transportation as prescribed in its Contractor Parking Policies. See transportation.ncsu.edu for current policies.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
- 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Project signs are not allowed.
- 1. Directional Signs: Directional signs for material deliveries are allowed within the construction area, if required, and shall be 4' wide x 2' high maximum, black and white only. The NCSU Project Manager shall approve the design of the sign and the sign text.
 - 2. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- H. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- I. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Final Acceptance.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Division 01 Section "Summary."
- C. 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."
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
 - 1. All pruning of existing plant materials, including roots and limbs, for construction clearances shall be done by a trained, licensed, insured arborist and according to standards set forth in the National Arborist Association publication "Standards for the Pruning for Shade Trees". All pruning shall be coordinated with and inspected by NC State Grounds Management.
 - 2. Walks, Root Zones, and Lawn Protection: A permit, issued by NC State Grounds Management, is required for vehicular access to brick and landscape areas. For single loads up to 9000 lbs, a ¾" minimum plywood base shall be placed over brick paving, root zones of trees, and lawn areas to be protected from vehicular work traffic. For single loads over 9000 lbs, two layers of ¾" plywood are required. Root zones and lawn areas shall not be covered with plywood for more than 3 consecutive days.
 - 3. For Work requiring multiple heavy loads into a construction landscape protection zone, or requiring protection for more than 3 consecutive days, a construction entry road shall be established. Construction entry shall consist of 10' by 16' oak logging mats on 6" coarse chipped, hardwood placed on a permeable structural filter fabric, top-dressed with an additional 10" of hardwood mulch. Mulch and logging mats shall be supplemented throughout the project to keep the access area structurally functional. At the end of the project, the logging mats shall be offered to Facilities Operations for salvage or disposed of off site at the discretion of the Owner.
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Final Acceptance. Perform control operations lawfully, using environmentally safe materials.

- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals 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.
 2. Construction of Fence: heavy-duty chain link material, having a minimum height of six feet and a continuous top tubular rail
 - a. Swing gates shall be included at every access to the enclosed area and shall be lockable.
 - b. The fence shall have an integral visual barrier or shall have shading type material applied and maintained for the duration of the project.
 - c. Locks for the gates shall be interlocked with a padlock provided by NCSU in order to allow access by NCSU or other emergency personnel in case of emergency.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- I. Keys: When necessary to perform the Work, the Contractor may be issued keys to existing mechanical and electrical spaces by the Owner. These keys shall be returned at the end of the project prior to Final Completion.
1. These keys shall not be duplicated without the consent of the Owner.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary 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.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with NC State Fire Marshal and local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
- N. Provide a project security program, to:

1. Protect Work, stored products and construction equipment from theft and vandalism.
2. Protect premises from entry by unauthorized persons.
3. Protect Owner's operations at site from theft, vandalism or damage from Contractor's work or employees.
4. Initiate security program in compliance with Owner's system, prior to job mobilization.
5. Maintain security program throughout construction period, until Owner occupancy or Owner acceptance precludes the need for Contractor security.
6. Identification
 - a. Provide identification to each person authorized to enter the Project premises, showing:
 - 1) Personal photograph
 - 2) Name of the individual and assigned number
 - 3) Name of employer
 - b. Maintain a current list of accredited persons; submit a copy of the list to Owner on request.
 - c. Require that identification be displayed by all persons entering, and on, the premises.
7. Exclude from site personnel not properly identified.
8. Entrance Control
 - a. Provide control of all persons and vehicles entering and leaving Project site.
 - 1) Require display of proper identification by each person.
 - 2) Allow no visitors except with issuance of temporary identification.
 - 3) Maintain log of visitors.
 - b. Owner will control deliveries and vehicles related to his own operations.
9. Patrol/Guard Service
 - a. Contractor has the option of placing or not placing a watchman at the site at all times when the buildings are not in the charge of his superintendent. Contractor shall be responsible at all times for all work and materials.
 - b. However, Contractor shall employ and pay for a watchman at all times, except normal working hours, that temporary heat is being used and as deemed necessary to meet provisions of the Contract.

3.6 MUD CONTROL

- A. Provide methods, means and facilities to prevent the depositing of mud, etc., on public thoroughfares or Owner-used roads. Provide periodic inspection of traffic areas to enforce requirements.

3.7 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: 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 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.
- 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, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall 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 permanent HVAC system to control humidity.
 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.
 - 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 materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.8 MOISTURE AND MOLD FIELD QUALITY CONTROL INSPECTIONS

- A. The Owner may elect to engage a Certified Industrial Hygienist to perform the following inspections during the installation of insulation and drywall products. The investigation and report preparation shall be completed under the direction of the Certified Industrial Hygienist.
1. Perform a visual inspection of the new construction areas monthly, from the beginning of insulation and drywall installation until inspections are terminated by the owner, to identify possible areas of mold or mildew growth due to the presence of moisture. Attention will be paid to areas where growth is likely, such as dust and dirt accumulation, areas with excessive moisture from rain, leaks and condensation.
 2. Perform a visual inspection of the air handling units as each unit becomes accessible. Particular attention will be paid to conditions that may be conducive to mold or mildew growth such as system cleanliness, filter conditions, condensate drainage, and signs of visible growth.
 3. Measurements shall be taken to assess airborne levels of mold in the construction area. Sampling for airborne and surface mold will be performed using instrumentation and sampling methods described herein. One (1) plate shall be used for each sample containing Malt Extract Agar. An Anderson N6 impactor sampler will be used to collect the airborne samples.
 - a. Surface samples will be collected using either sterile transport swabs or transparent tape lift methods.
 - b. Bio-aerosol samples will be sent to the microbiological laboratory for incubation and identification.
 - c. Moisture meters and infrared thermographs will be used to identify areas and building components with high moisture content.
 4. If deemed necessary by the Owner, the Contractor and affected Sub-Contractors and their on-site staff shall attend instructional programs designed to demonstrate awareness and the proper handling of materials to avoid moisture and mold issues.
 5. A written report shall be prepared listing all findings with recommendations for corrective action, if applicable, after each inspection. The report will include:
 - a. A list of problem areas and recommendations for corrective action.
 - b. Status of previous action.
 - c. List of items corrected.
- B. Insulation and drywall products will be considered defective if they do not pass tests and inspections.
1. The Contractor shall repair or remove work where test results and inspections indicate that it has been deemed to contain unsatisfactory amounts of moisture or mold.
 2. Defective products shall be repaired or removed and replaced at no additional expense to the Owner.
 3. Testing and inspections will continue until the work is deemed to be free of moisture and mold.

3.9 POLLUTION CONTROL

- A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.
- B. Provide equipment and personnel, perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids. Excavate and dispose of any contaminated earth off-site in a safe legal manner, and replace with suitable compacted fill and topsoil.
- C. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.
- D. Provide systems for control of atmospheric pollutants.
 - 1. Prevent toxic concentrations of chemicals
 - 2. Prevent harmful dispersal of pollutants into the atmosphere

3.10 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Final Acceptance.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Final Acceptance. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Final Acceptance, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 - 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. Division 01 Section "Substitution Procedures" for requests for substitutions.
 - 2. Division 01 Section "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, which is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable (Equivalent) Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section,

provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.4 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a comparable product request. Architect will notify Contractor through Construction Manager 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 Approval: As specified in Division 01 Section "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 Division 01 Section "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.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "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 not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect through Construction Manager in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect; whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."

3. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
 - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
 4. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
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.

2.3 BANNED MATERIALS

- A. The Owner and Architect have not knowingly included any product which includes lead-based paint, PCBs or asbestos fiber.
- B. The Contractor shall not purchase or install any product which, to his knowledge, knowingly incorporates lead based paint, PCBs or asbestos fiber in its manufacture or packaging whether a named product, a basis of design product, a comparable product or any product otherwise included on the drawings or in the project manual.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 – EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

- B. Related Requirements:

1. Division 01 Section "Summary" for limits on use of Project site.
2. Division 01 Section "Submittal Procedures" for submitting surveys.
3. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
4. Division 02 Section "Selective Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

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. Certified Surveys: Submit two copies signed by land surveyor.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

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. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Provide lintels in masonry where required. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection. Coring of concrete and masonry shall not be permitted without the prior approval of the Architect.
 - 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.
 - m. Sports facility internal and external broadcast systems.
 - 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. Roofing systems
 - 1) Employ manufacturer or manufacturer's approved installer to perform cutting and patching on roofing systems as required to maintain existing warranty.
 - d. Exterior curtain-wall construction.
 - e. Sprayed fire-resistive material.
 - f. Equipment supports.
 - g. Piping, ductwork, vessels, and equipment.
 - h. 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.
- a. Employ manufacturer or manufacturer's approved installer to perform cutting and patching on weather-exposed or moisture resistant building envelope elements.
- C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, 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.
 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 and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish 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 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.

3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- 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. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of **96 inches (2440 mm)** in occupied spaces and **90 inches (2300 mm)** in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Final Acceptance.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful 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 work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
 - a. Where sleeves have not been provided, holes in masonry walls and concrete slabs and walls shall be core drilled
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.
- K. Repair or remove and replace damaged, defective, or nonconforming Work.
 - 1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
 - 2. Where cutting results in the unintended removal of or damage to operational, structural or other construction elements, the Contractor shall stop work, report the condition to the Architect and proceed again only after an emergency plan of action has been approved for implementation.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill. Coring of concrete and masonry shall not be permitted without the prior approval of the Architect.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final

paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
 6. Where underground services are installed below existing site paving, curbing, grass, etc., damaged and disturbed areas shall be restored to their original condition.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (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 in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Final Acceptance.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Temporary Facilities and Controls" and Division 01 Section "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Final Acceptance.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure 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 Division 01 Section "Commissioning."
- B. Permanent equipment used for temporary services:
 1. Any permanent equipment used for temporary service must undergo (before being used) manufacturer's supervision and startup services as specified in the technical sections of the specifications.
 2. Upon completion of such use of permanent equipment, equipment must again undergo manufacturer's supervision and startup services no earlier than one month prior to Final Acceptance.
- C. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- D. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

- E. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Final Acceptance.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work, at the Owner's option.. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
 - 2. Nonconforming Work includes any Work that deviates from the Contract Documents ("*Drawings and Specifications*"), that was furnished, installed and/or provided, without prior written approval of the deviation.
 - 3. The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.
- 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 01 73 00

SECTION 01 74 19 - 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 Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for environmental-protection measures during construction.
 - 2. Division 02 Section "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.
 - 3. Division 31 Section "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 and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Hazardous Waste: Any solid waste that is ignitable, corrosive, reactive, or toxic; a listed hazardous material or containing a listed hazardous material per Title 40 Code of Federal Regulations Parts 260-270.
- E. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- F. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

- G. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.
- H. Universal Waste: Hazardous wastes that have been provided specific exemptions (40CFR 273) to encourage recycling. Universal wastes are limited to recalled or cancelled pesticides and intact batteries, lamps, and mercury containing devices.
- I. Yard Waste: A solid waste consisting solely of vegetative matter resulting from landscaping maintenance.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste remains the property of the Owner.
- 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 3 copies of plan within 7 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

- A. General: Contractor to provide all forms required by this section.
- B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Owner's standard forms administered by Office of Waste Reduction & Recycling (<http://recycling.ncsu.edu>).
- C. Waste Reduction Calculations: Before request for Final Acceptance, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- F. 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.

- G. 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.
- H. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- J. Refrigerant Recovery: Comply with requirements in Division 02 Section "Structure Demolition" for refrigerant recovery submittals.

1.7 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.
- B. Refrigerant Recovery Technician Qualifications: Universal certified by EPA-approved certification program.
- C. Refrigerant Recovery Technician Qualifications: Comply with requirements in Division 02 Section "Structure Demolition."
- D. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- E. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.

- B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Division 02 Section "Structure Demolition."
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- D. 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 Form CWM-5 for construction waste and Form CWM-6 for demolition waste. Include the following:
1. Total quantity of waste
 2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers 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 hauling and tipping fees by donating materials
 7. Savings in hauling 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

1.9 UNIVERSITY WASTE RESOURCES

1. At the contractor's option and when available, the contractor may utilize University contract pricing for related facility tip costs or recycling rebates.
 - a. Contractor shall coordinate with Owner and University Waste Reduction and Recycling to utilize contract pricing.
2. At the contractor's option, the contractor may contract with University Waste Reduction and Recycling for Rolloff Dumpster use.
 - a. Contractor shall coordinate with Owner and University Waste Reduction and Recycling for rolloffs.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:
 - a. Asphalt paving.
 - b. Concrete.
 - c. Concrete reinforcing steel.
 - d. Brick.
 - e. Concrete masonry units.
 - f. Wood studs.
 - g. Wood joists.
 - h. Plywood and oriented strand board.
 - i. Wood paneling.
 - j. Wood trim.
 - k. Structural and miscellaneous steel.
 - l. Rough hardware.
 - m. Roofing.
 - n. Insulation.
 - o. Doors and frames.
 - p. Door hardware.
 - q. Windows.
 - r. Glazing.
 - s. Metal studs.
 - t. Gypsum board.
 - u. Acoustical tile and panels.
 - v. Carpet.
 - w. Carpet pad.
 - x. Demountable partitions.
 - y. Equipment.
 - z. Cabinets.
 - aa. Plumbing fixtures.
 - bb. Piping.
 - cc. Supports and hangers.
 - dd. Valves.
 - ee. Sprinklers.
 - ff. Mechanical equipment.
 - gg. Refrigerants.
 - hh. Electrical conduit.
 - ii. Copper wiring.
 - jj. Lighting fixtures.
 - kk. Lamps.
 - ll. Ballasts.
 - mm. Electrical devices.

- nn. Switchgear and panelboards.
- oo. Transformers.

2. 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.
- l. 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.

3. Owner-directed Recyclables: Regardless of salvage/recycle goal indicated in "General" Paragraph above, 100 percent of the following materials shall be recycled:

- a. Cardboard
- b. Bottles and cans
- c. Scrap metal and wire
- d. Concrete
- e. Asphalt (paving and shingles)
- f. Aggregate
- g. Brick and CMU

B. Yard Waste: Achieve end-of-Project rates for landfill diversion of 100 percent of total yard waste generated by the Work.

2.2 CONTAINERS FOR HAZARDOUS, UNIVERSAL, AND SPECIAL WASTES

- A. Containers used for waste storage shall be approved by US Department of Transportation for transport.
 - 1. Containers shall be resealable to allow enclosed storage of waste and reopening for depositing of new waste.
 - 2. Containers shall be provided by Owner for items collected by Owner.
- B. Hazardous waste containers shall have labels to clearly identify waste stream.
 - 1. Include date of initial accumulation on label.
 - 2. Separate containers shall be used for each waste stream. Containers shall not contain waste for multiple streams.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by Architect and Owner. 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 Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 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.
- D. 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, recycled, reused, donated, and sold.
 - 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. General: Salvage of Construction and Demolition Waste for Reuse shall be the preferred method of disposal.

- B. Evaluate salvaged materials for use in University construction projects.
 - 1. Where use in construction is not feasible but items may have resale value, contact NC State Surplus Property Services. Contact Waste Reduction and Recycling for assistance with disposition.
 - 2. Where a vendor can be identified, coordinate recycling through available take-back programs.
- C. Salvaged Items for Owner's Use:
 - 1. Clean salvaged items
 - 2. Pack or crate items after cleaning. Identify contents of containers
 - 3. Store items in a secure area until delivery to Owner
 - 4. Transport items to Owner's storage area designated by Owner
 - 5. Protect items from damage during transport and storage
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.
- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Where salvage of Construction and Demolition Waste is not feasible, recycling shall be the preferred method of disposal.
- B. On-site Paper and Beverage Containers: Recycle paper and beverage containers used by on-site workers.
- C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.
- D. 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.
- E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are 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 off Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphaltic Concrete Paving: Grind asphalt to maximum **1-1/2-inch (38-mm)** size.
 1. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.
- B. Asphaltic Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 1. Pulverize concrete to maximum **1-1/2-inch (38-mm)** size
 2. Crush concrete and screen to comply with requirements in Division 31 Section "Earth Moving" for use as satisfactory soil for fill or subbase
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 1. Pulverize masonry to maximum **3/4-inch (19-mm)** size.
 - a. Crush masonry and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.
 - b. Crush masonry and screen to comply with requirements in Division 32 Section "Plants" for use as mineral mulch.
 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 1. Structural Steel: Stack members according to size, type of member, and length.
 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- H. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
 - 1. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
- J. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- K. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- M. Plumbing Fixtures: Separate by type and size.
- N. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- O. Lighting Fixtures: Separate lamps by type and protect from breakage.
- P. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.
- Q. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 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. Site-Clearing Wastes: Chip brush, branches, and trees at landfill facility.
- C. 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.

- a. Comply with requirements in Division 32 Section "Plants" for use of clean sawdust as organic mulch.
- D. Gypsum Board: Stack large clean pieces on wood pallets 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.
 - a. Comply with requirements in Division 32 Section "Plants" for use of clean ground gypsum board as inorganic soil amendment.
- E. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and deliver to a Construction and Demolition recycling and reclamation facility with current NC Department of Environmental Quality permit for sorting.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

3.7 HAZARDOUS, UNIVERSAL, AND SPECIAL WASTES

- A. Manage hazardous, universal, and special wastes separately from other Construction & Demolition waste.
- B. Coordinate disposal with NC State Environmental Health & Safety.
- C. Store waste containers in a secured, covered, and well identified area of the site.
 - 1. Waste shall not be stored on site for more than 90 days.
 - 2. Inspect waste stored on site for more than six days. Inspections shall be conducted and documented no less than weekly.
- D. Provide spill response supplies adequate to contain 110% of any accumulated waste.
 - 1. If a spill occurs, notify Owner and proceed with spill containment and cleanup.
- E. Provide Owner with copies of all hazardous, universal, and special waste disposal certificates and/or manifests for all waste shipped.

END OF SECTION 01 74 19

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Final Acceptance procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

- B. Related Requirements:

1. Division 01 Section "Payment Procedures" for instructions for the preparation of the final payment application.
2. Division 01 Section "Photographic Documentation" for providing final completion construction photographic documentation.
3. Division 01 Section "Execution" for progress cleaning of Project site.
4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
5. Division 01 Section "Project Record Documents" for submitting record documents and record submittals.
6. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Final Acceptance.
- C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 CLOSEOUT DOCUMENTS

- A. Certificates of Release: From authorities having jurisdiction.

1. Certificate of Occupancy
2. Certificates of Inspection
 - a. Elevators
 - b. Mechanical
 - c. Electrical
 - d. Fire Protection

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

D. Miscellaneous Closeout Documents: As specified in individual trade Specification Sections.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material items specified in other Sections.

1.6 FINAL ACCEPTANCE 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. Submit a list of all Closeout Documents, including the location of document delivery, format and number of copies, for review by the Architect and Owner.

C. Submission Prior to Final Acceptance: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Final Acceptance. 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, final completion construction photographic documentation, property surveys and similar final record information.
3. Submit closeout submittals specified in individual trade Specification Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual trade Specification Sections, including tools, spare parts, extra materials. Label with manufacturer's name and model number where applicable.
 - 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 Owner's signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
 6. Submit sustainable design submittals not previously submitted.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- D. Procedures Prior to Final Acceptance: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Final Acceptance. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Final Acceptance.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems as specified in individual trade Specification Sections.
 6. Submit demonstration and training video recordings as specified in individual trade Specification Sections.
 7. Advise Owner of changeover in heat and other utilities.
 8. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 10. Complete final cleaning requirements, including touchup painting.
 11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- E. Inspection: Submit a written request for inspection to determine Final 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 Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Final Acceptance 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. Should Architect determine that Work is not substantially complete, he will promptly notify Contractor in writing, giving the reasons therefor.
 2. Contractor shall remedy deficiencies, and send a second written notice of Final Acceptance, and Architect will reinspect the Work.
 3. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 4. Results of completed inspection will form the basis of requirements for final completion.
 5. Reinspection Fees: Should Architect perform reinspections due to failure of Work to comply with claims made by the Contractor, Owner will compensate Architect for such additional services, and deduct the amount of such compensation from final payment of the Contractor.

1.7 FINAL COMPLETION PROCEDURES

- A. Submissions Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Final Acceptance 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.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. 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 Construction Manager 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect and Construction Manager.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect, through Construction Manager, will return annotated file.
 - b. PDF electronic file. Architect, through Construction Manager, will return annotated file.

- c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).
- d. Three paper copies. Architect, through Construction Manager, will return two copies.

1.9 SUBMISSION OF PROJECT WARRANTIES

- A. Time of Submission: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Final Acceptance is indicated, or when delay in submission of warranties might limit Owner's rights under warranty.
 1. Compile specified warranties and bonds
 2. Compile specified service and maintenance contracts
 3. Compile specified product and Contractor's certifications and certificates
 4. Review documents to verify compliance with Contract Documents
 5. Co-execute documents when so specified
- 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.
 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.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond documents package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. 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 Final Acceptance for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, 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 neither planted nor 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. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - j. 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.
 - k. Remove labels that are not permanent.
 - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

- o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
 - p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - q. 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 Division 01 Section "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Final Acceptance.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
- 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

SECTION 01 78 23 - 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. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory
 - 2. Emergency manuals
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Sections include the following:
 - 1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
 - 3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
 - 4. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

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 by uploading to web-based project software site. Enable reviewer comments on draft submittals.
 2. Submit three Insert number paper copies. Architect, through Construction Manager, will return two Insert number copies.
- C. Initial Manual Submittal: Submit 2 draft copies of each manual at least 30 days before requesting inspection for Final Acceptance. Include a complete operation and maintenance directory. Architect will return one copy of draft and mark whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
1. Correct or modify each manual to comply with Architect's and Commissioning Authority's comments. Submit 3 copies of each corrected manual within 15 days of receipt of comments and prior to commencing demonstration and training.
- E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 COORDINATION

- A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
1. List of documents
 2. List of systems
 3. List of equipment
 4. Table of contents
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. 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.

- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- 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 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. 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 oversized 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.

1.8 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: 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: Enclose title page in transparent plastic sleeve. 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, address, and telephone number of Contractor, including responsible principal and their telephone number
 6. Name and address of Architect
 7. Cross-reference to related systems in other operation and maintenance manuals
- C. Quality Assurance
 1. Preparation of data shall be done by personnel:
 - a. Trained and experienced in maintenance and operation of described products
 - b. Familiar with requirements of this Section
 - c. Skilled as technical writer to the extent required to communicate essential data
 - d. Skilled as draftsman competent to prepare required Drawings
- D. 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.
 2. List, with each product, name, address and telephone number of:
 - a. Subcontractor or installer
 - b. Maintenance contractor, as appropriate
 - c. Identify area of responsibility of each
 - d. Local source of supply for parts and replacement

3. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
- E. 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.
1. Coordinate Drawings with information in Project Record Documents to assure correct illustration of completed installation. Do not use Project Record Documents as Maintenance Drawings.
 2. Written text, as required to supplement product data for the particular installation:
 - a. Organize in consistent format under separate headings for different procedures
 - b. Provide logical sequence of instructions for each procedure
 3. Copy of each warranty, bond and service contract issued.
 - a. Provide information sheet for Owner's personnel, give:
 - 1) Proper procedures in event of failure
 - 2) Instances which might affect validity of warranties or bonds
 4. Copy of operating permits from the appropriate authority having jurisdiction. Original permits shall be delivered directly to the Owner with a copy of the transmittal submitted to Architect for record.
- F. 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."

1.9 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.

1.10 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

1.11 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
2. Performance and design criteria if Contractor are 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
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.

1.12 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.

1.13 PRODUCT MAINTENANCE MANUAL

- 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.
- 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 - (Not Used)

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. 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.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 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.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, 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.
 - 1. 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.
- F. 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 operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."
- G. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - 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 Documents.
 - 2. Record Submittals.
 - 3. Signature of Contractor or his authorized representative, certifying the correctness and completeness of the Record Documents
- B. Related Requirements:
 - 1. Division 01 Section "Project Management and Coordination" for coordination drawings for record.
 - 2. Division 01 Section "Submittal Procedures" for general submittal procedures.
 - 3. Division 01 Section "Execution" for final property survey.
 - 4. Division 01 Section "Closeout Procedures" for providing closeout documents.
 - 5. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 6. Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Specifications: Submit one paper copy and annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- B. Record Product Data: Submit one paper copy and 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.
- C. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy and annotated PDF electronic files and directories of each submittal.

- D. 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.
- E. Coordination Drawings: Refer to Specification Section 01 31 00 for requirements.

1.4 RECORD SUBMITTALS

- A. Record Product Data: Submit one paper copy and annotated PDF electronic files and directories of each submittal. Include the “as fabricated/manufactured” condition of the product that is described. Additionally, include any modifications that were made in the field, showing the “as installed/erected” condition of the product that is described. Record Product Data is only required where specifically noted in the individual trade Specification Sections.
 - 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.
- B. Record Shop Drawings: Include the “as fabricated/manufactured” condition of the element that is detailed on the shop drawing. Additionally, include any modifications that were made in the field, showing the “as installed/erected” condition of the element that is detailed on the shop drawing. Record Shop Drawings are only required where specifically noted in the individual trade Specification Sections.
- C. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately before Final Acceptance, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit one paper copy and annotated PDF electronic files and directories of each submittal. Miscellaneous records include, but are not limited to, the following:
 - 1. Field records on excavations and foundations.
 - 2. Field records on underground construction and similar work.
 - 3. Surveys showing locations and elevations of underground lines.
 - 4. Invert elevations of drainage piping.
 - 5. Surveys establishing building lines and levels.
 - 6. Authorized measurements using unit prices or allowances.
 - 7. Records of plant treatment.
 - 8. Ambient and substrate condition tests.
 - 9. Certifications received in lieu of labels on bulk products.
 - 10. Batch mixing and bulk delivery records.
 - 11. Testing and qualification of trade's persons.
 - 12. Documented qualification of installation firms.
 - 13. Load and performance testing.
 - 14. Inspections and certifications by governing authorities.
 - 15. Leakage and water-penetration tests.
 - 16. Fire-resistance and flame-spread test results.
 - 17. Final inspection and correction procedures.

1.5 RECORD DRAWINGS AND SHOP 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 archive 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 below first floor.
 - 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.
 - o. Field changes of dimension or data
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Final Acceptance, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file with comment function enabled.

2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" or "PROJECT RECORD SHOP DRAWING," as appropriate, in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings 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.
 - e. Name of Contractor.

1.6 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file.

1.7 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.
- D. RECORD SAMPLES
1. Immediately before date of Final Acceptance, meet with Architect and Owner's personnel at Project site to determine which Samples maintained during the construction period shall be transmitted to Owner for record purposes.
 2. Comply with Architect's instructions for packaging, identification marking, and delivery to Owner's Sample storage space. Dispose of other Samples in the manner specified for disposing surplus and waste materials.

1.8 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.

1.9 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.

PART 2 - (Not Used)

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- 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. Maintenance of Record Documents and Samples: Store record documents and Samples 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 reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - 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. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment
 - 2. Training in operation and maintenance of systems, subsystems, and equipment
 - 3. Demonstration and training videos
- B. Related Sections include the following:
 - 1. Division 01 Section "Project Management and Coordination" for requirements for preconstruction conferences
 - 2. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including 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. At completion of training, submit one complete training manual(s) for Owner's use.
- B. Qualification Data: For facilitator, instructor and photographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project
 - b. Name and address of photographer
 - c. Name of Architect
 - d. Name of Contractor
 - e. Date video was recorded
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction
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 Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 1. Inspect and discuss locations and other facilities required for instruction.
 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 3. Review required content of instruction.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- 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 has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - 1. Motorized doors, including overhead coiling grilles and automatic entrance doors.
 - 2. Equipment, including food-service equipment, and residential appliances.
 - 3. Fire-protection systems, including fire alarm, fire pumps and fire-extinguishing systems.
 - 4. Intrusion detection systems.
 - 5. Conveying systems, including wheelchair lifts.
 - 6. Medical equipment, including medical gas equipment and piping.
 - 7. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping and water distribution piping.
 - 8. Refrigeration systems, including chillers, cooling towers, condensers, pumps and distribution piping.
 - 9. HVAC systems, including air-handling equipment, air distribution systems and terminal equipment and devices.
 - 10. HVAC instrumentation and controls.
 - 11. Electrical service and distribution, including transformers, switchboards, panelboards, uninterruptible power supplies and motor controls.
 - 12. Packaged engine generators, including transfer switches.
 - 13. Lighting equipment and controls.
 - 14. Communication systems, including intercommunication, surveillance, voice and data and television equipment.
- 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:
 - 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. Operations manuals
 - c. Maintenance manuals
 - d. Project Record Documents
 - e. Identification systems
 - f. Warranties and bonds
 - g. 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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.
- B. Set up instructional equipment at instruction location.

3.2 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. 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, with at least seven days' advance notice.
 2. Provide multiple sessions to accommodate Owner's staff scheduling requirements.
- 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 written and a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEOS

- A. General: Engage a qualified commercial photographer to record demonstration and training in digital media format. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.
 - 1. Submit video recordings on CD-ROM or thumb drive.
 - 2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 - 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show 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 digital media either by audio narration by microphone while or dubbing audio narration off-site after digital media is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
- F. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video 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.

END OF SECTION 01 79 00

SECTION 01 91 00 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

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.
- B. Applicable Sections of Division 23 Specification.

1.2 SUMMARY

- A. Employment of Testing, Adjusting and Balancing Contractor:
 - 1. Construction Manager will employ and pay for services of a qualified organization to perform specified testing, adjusting and balancing (TAB) services.
 - 2. Employment of the organization shall in no way relieve Contractor's obligation to perform Work of the Contract.
 - 3. Organization shall be completely independent of all Division 23 Contractors and Subcontractors.
- B. This Section includes TAB to produce design objectives for the following:
 - 1. Air systems.
 - 2. Hydronic Piping Systems.
 - 3. Vibration measuring.
 - 4. Verifying that automatic control devices are functioning properly.
 - 5. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. BAS: Building Automation System.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- F. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

- G. TAB: Testing, adjusting, and balancing.
- H. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Notification of Deficiencies Report: Within 45 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report, notifying Architect of any deficiencies, as specified in "Examination" Article.
- C. Certified TAB Reports: Submit two copies of final TAB reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- D. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. The organization in which performs the TAB service shall be a current member in good standing, certified to perform services required for the project, of either:
 - 1. Associated Air Balance Council (AABC).
 - 2. National Environmental Balancing Bureau (NEBB).
- B. The TAB Work performed by TAB Contractor shall be under the direct supervision of a Registered Professional Engineer, a full-time employee of TAB Contractor. Technicians performing the work must be properly trained, experienced and full-time employees of TAB Contractor.
- C. Comply with applicable procedures and standards of the certification sponsoring association unless more stringent requirements are specified in this section; either:
 - 1. Current issue of "National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems", by AABC.
 - 2. Current issue of "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems", by NEBB.
 - 3. Calibration and maintenance of instruments shall be in accord with requirements of the standards. Instruments used in the performance of the TAB Work must have been calibrated within six months preceding the date of usage. Calibration histories for each instrument shall be included with the TAB report.
 - 4. Accuracy of measurements shall comply with the more stringent of the requirements of the standards or the tolerances specified hereinafter.
- D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- E. TAB Report Forms: Use standard forms from AABC or NEBB. Other forms may be used upon receiving prior approval from Architect or Owner.
 - F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Participate and cooperate with the efforts of Installing Contractor and/or factory-authorized service representatives for systems and equipment, and BAS Contractor to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide adequate advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. Provide a National Certification Guarantee from the AABC or the NEBB, applicable for the TAB work performed under this contract. Guarantee must include the following provisions:
 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. After completion of the work specified under this Section, provide an extended warranty encompassing one full heating season and one full cooling season, during which time any balancing device which had been adjusted earlier as part of this work shall be rechecked and reset when such additional work is deemed necessary by the Owner or the Architect.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Verify that quantities and locations of balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation. Prepare a report that identifies any deficiencies and specifically note required work to be done to allow effective balancing.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- I. Examine plenum ceilings or raised floors used for supply air to verify that they are airtight. Verify that pipe and duct penetrations and other holes are sealed.
- J. Examine strainers for clean screens.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.

2. Dampers and valves are in the position indicated by the controller.
 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- P. Report deficiencies discovered before and during performance of TAB procedures. Record default set points if different from indicated values.

3.2 DUCTWORK LEAKAGE TEST VERIFICATION

- A. Installing Contractor will install ductwork as specified in Section 23 30 00 and will perform leakage tests. TAB Contractor shall witness all duct leakage tests.
- B. Verify and record that all duct sections have been tested, indicate both successful and unsuccessful tests. Verify sections where resealing and retesting resulted in successful tests. Include date of tests and initials of balancing technician who witnessed tests.

3.3 PREPARATION

- A. Complete system readiness checks and prepare system readiness reports. Include verification of the following:
 1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Isolating and balancing valves are open and control valves are operational.
 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB, and otherwise as specified in this Section.
- B. Obtain approved submittals for all equipment and devices required for proper system balancing. Balance systems to achieve capacities and flow quantities indicated on drawings and approved submittals. Should there be a conflict between the drawings and submittals, the approved submittal values shall be used.

- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed- control levers, and similar controls and devices, to show final settings.
- E. Take and report testing and balancing measurements in the same units, inch-pound (IP) or metric (SI), to match what is shown on Contract Documents.

3.5 BALANCING TOLERANCES

A. Air Balancing:

- 1. All measured air quantities shall agree with design air quantities within tolerances listed herein or otherwise acceptable to the Architect. The measurements recorded in the TAB Report for the total CFM of all branches, and the grand total shall agree with the measured air volume of the fan, less an air quantity not greater than the specified maximum percentage of leakage.
- 2. Balance all equipment, air outlets and air intakes in accordance with the air quantities shown on the drawings with permissible tolerances as follows:

a. Supply, return and exhaust fans

- 1) Fan serving multiple rooms -5% to +10%
- 2) Fan serving individual room $\pm 5\%$

b. Minimum outside air

-0% to +5%

c. Terminal Units

- 1) Terminal unit serving multiple rooms -5% to +10%
- 2) Terminal unit serving individual room $\pm 5\%$

d. Air Outlets

- 1) Room with multiple outlets $\pm 10\%$
- 2) Room with individual outlet $\pm 5\%$

- B. Water Balancing: Balance all hydronic equipment, pumps, coils, etc in accordance with the capacities and flow quantities shown on the drawings within an acceptable tolerance of $\pm 5\%$.
- C. If during progress of the construction or during balancing, the TAB Contractor encounters any condition that will not allow balancing to be performed within the above balancing tolerances, the fact(s) shall be reported immediately to the Architect with recommendations for corrective action. If feasible, report such conditions and recommendations prior to submission of balancing reports. Work shall then proceed in accordance with the response provided by the Architect.

3.6 AIR SYSTEM BALANCING

- A. Prepare test reports for all air systems. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Locate start-stop and disconnect switches, electrical interlocks, motor starters, variable frequency motor speed controllers and DDC panels.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check condensate drains for proper connections and functionality. Confirm plenum pressure at trap connection and confirm trap depth and arrangement is in accordance with drawing detail.
- G. Check for proper sealing of air-handling unit components.
- H. Verify that clean filters have been provided by Installing Contractor. Simulate specified dirty filter condition when balancing.
- I. Provide pitot tube test openings with covers as required for taking pressure and velocity readings in ductwork. Install openings and covers of a type and in a manner to insure against leakage. Remove, replace and repair insulation at pitot tube test openings in a neat and workmanlike manner. Where permanent instrument test ports are specified, advise Installing Contractor as to proper location.
- J. Measure air quantities in main ducts by pitot tube traverse of the entire cross sectional area of the duct. Where air measuring stations have been installed, measure air quantities by pitot tube traverse and verify calibration of air measuring station. Do not use air measuring station for balancing purposes. Where necessary for proper balancing, make similar measurements in branch ducts. Determine outlet and inlet air quantities in accordance with outlet and inlet manufacturer's recommendations.
- K. Obtain total air quantities by adjustment of fan speeds or adjustment of belts and sheaves. Adjust branch duct air quantities by volume dampers. Permanently mark dampers after air balance is complete.
- L. Volume dampers shall be used to balance air quantities at outlets and inlets, providing final adjustments do not produce objectionable drafts or sound levels. Air quantity adjustments using outlet pattern deflectors will not be permitted.
- M. Balancing variable air volume (VAV) systems:
 - 1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set- point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 - 2. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Measure total system airflow. Adjust to

within indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units.

3. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets.
4. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.
5. Balance at design (maximum) airflow and to deliver design minimum outside air at both design maximum and design minimum total airflow. Determine minimum fan speed and system static pressure that will satisfy requirements and advise BAS Contractor accordingly. Retest at simulated partial load conditions, at scheduled minimum airflow.
6. Record the final fan performance data at maximum and minimum flow conditions. Using fan curves obtained from approved submittals, plot maximum and minimum operating conditions on fan curve and include in final report.
7. Test variable frequency drives through full range of Hertz for operating points that cause excessive vibration due to harmonic frequency, and program VFD to prevent operation at those frequencies.

N. Outside Air and Relief Air (Economizer) Damper Setup Procedure:

1. All airflow station calibration should be checked prior to beginning procedure listed below.
2. These procedures should be performed during unoccupied hours, since building temperatures will not be maintained during the adjustment procedure.
3. Disassociate AHU relief air damper control signal from outside air damper and return air damper control signal. Relief air damper shall be modulated to maintain return fan discharge static pressure at setpoint (Relief air damper setpoint to be initially set to +0.20”).
4. De-energize all associated exhaust fans.
5. Index outside air damper to 100% open and return damper to 100% closed.
6. Index all associated AVB boxes to maximum scheduled airflow (This should cause supply fan VFD to index to near maximum design speed).
7. Set supply/return differential setpoint to zero. Replace or adjust the return fan sheave so that at VFD maximum speed the return fan airflow is less than or equal to the scheduled return fan airflow.
8. Set supply/return differential setpoint to scheduled minimum outside air cfm (This should slow down the return air fan VFD). Disable economizer controls and reset outside air and return air dampers to automatic control (outside air damper should be at minimum position and return air damper should be mostly open).
9. Energize all associated building general exhaust fans.
10. Adjust return damper position to maintain 0.10” positive pressure in the return fan discharge ductwork (this should establish maximum return damper and minimum outside air damper positions). Relief damper should be closed and the outside airflow sensor should now read near the supply/return differential setpoint set in 8 above (There will be a difference due to flow sensor inaccuracy at low o/a flow).
11. Complete steps 1 to 10 above for each air handling unit. After completing set-up on all units, check return fan discharge pressure at each unit. The pressure should still be +0.1” at minimum outside airflow.
12. Check building pressurization at front doors, if it seems to take excess pressure to open doors or if there seems to be an in rush of air when doors are opened, increase supply/return differential setpoints for each air handling unit by 5%. (Note: Only perform this step when there is little or no wind outside).

14. Perform step 12 until the building is at a neutral or slightly positive pressure.
 15. Index all boxes to minimum scheduled airflow and check building pressurization at front doors (it should be the same as at the end of step 13).
 16. Index unit for 100% outside air and check building pressurization at front doors (again it should not change).
 17. Return all systems to automatic control and check building pressurization at the front doors (final check that building pressurization is the same as it was after step 13).
 18. After final set-up of all units is completed, submit to the owner a report containing:
 - a. Final supply/return differential setpoint for each unit.
 - b. Description of apparent building pressurization after AHU setup is completed.
 - c. One hour trend logs for each unit listing: supply air CFM, return air CFM, outside air CFM (as measured at o/a flow station), and return fan discharge static pressure. These readings shall be taken every 5 minutes for one hour after AHU setup is complete.
- O. Air Volume Control Boxes and Air Flow Measuring Stations: Check each terminal unit and air flow measuring station for calibration and adjust as necessary.
1. For Air Volume Control Boxes and Air Flow Measuring Stations with DDC Controls
 - a. BAS Contractor will set up and calibrate the mass flow control device to the design contract values.
 - b. BAS Contractor will index the system configuration as requested by TAB Contractor.
 - c. TAB Contractor shall then test the mass flow output and shall proportionately adjust the distribution. If the mass flow results deviate from the design intent by greater than the nominal ($\pm 5\%$) amount, TAB Contractor shall provide those values to BAS Contractor for final adjustment.
 - d. BAS Contractor will modify the previously mentioned correction factor to cause the controlled value to be consistent with the field measured value.
 - e. TAB Contractor shall then retest as required to confirm that such corrections have resulted in values that conform to the specification requirements.
- P. Diffuser Pattern Adjustment: Adjust individual outlets under procedures recommended by the manufacturers of the outlets, or as otherwise approved by Architect. Set pattern deflectors at each outlet for the air pattern required. Make changes in air patterns or settings necessary to achieve correct air balance and to minimize drafts. Bring to the attention of the Installing Contractor any air outlets with noticeable rattle caused by loose dampers or pattern adjusters.

3.7 AIR BALANCING DATA

- A. Include the following data in the TAB Reports:
1. Air Moving Equipment Data
 - a. Fan or Unit No.
 - b. Location
 - c. Area Served
 - d. Manufacturer
 - e. Model No. and Serial No.
 - f. Rated and Actual Motor Data

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- 1) HP
 - 2) Phase
 - 3) Voltage
 - 4) Amperage
- g. Design and Actual Air Flow Measurements
- 1) Total CFM
 - 2) Outside air CFM at minimum OA damper setting
 - 3) Total and external static pressures, in w.g.
 - 4) Fan suction static pressure, in w.g.
 - 5) Fan discharge static pressure, in w.g.
 - 6) Fan RPM
- h. Design and Actual Pressure Drops
- 1) Across filter bank
 - 2) Across each heat transfer coil
 - 3) Provide complete pressure drop profile across each component in air handling unit
- i. Static pressure controls' identification (by service) and final setpoint.
- j. Evaluate building and room pressure conditions to determine adequate supply and return air proportions.
- k. Fan curves with actual operating conditions indicated.
2. Controllable Speed Fan with Variable Frequency Motor Speed Controller
- a. Establish the maximum speed setpoint by determining the following at maximum design air flow requirements:
- 1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.
 - 2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
 - 3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.
- b. Establish the minimum speed setpoint by determining the following at minimum design air flow requirements:
- 1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.
 - 2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
 - 3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.
- c. Record the operating conditions of the controllable speed fan system(s) with variable frequency motor speed controller(s) at the time the preceding work is performed, including control settings, damper positions, filter conditions and other pertinent data, to

permit duplication of all operating conditions during final calibration of the controllable speed fan variable frequency motor speed controller(s).

- d. After final calibration of the fan controller(s) has been performed again duplicate all system operating conditions and repeat the balancing and adjusting work, specified above, to demonstrate the proper operation, control and calibration of each controllable speed fan system variable frequency motor speed controller at both minimum and maximum air flow conditions.

3. Air Flow Measuring Station

- a. Fan or unit number
- b. Station symbol and location
- c. Manufacturer and model number
- d. Design and actual velocity
- e. Design and actual cfm

4. Duct Velocity Traverse Data

- a. Fan or Unit No.
- b. Traverse location.
- c. Design and actual CFM.
- d. Duct dimensions and area.
- e. Design and actual average velocity.
- f. Duct static pressure at test holes, in. w.g.
- g. Traverse measurements in FPM (show grid pattern).

5. Air Volume Control Box Data

- a. Unit symbol and location.
- b. Manufacturer and model number.
- c. Design and actual air velocity.
- d. Design and actual CFM.

6. Air Outlet and Inlet Data

- a. Identify each outlet or inlet as to location, area and fan or unit system.
- b. Manufacturer and model number.
- c. Outlet or inlet size, effective area or Ak factor.
- d. Design and actual velocity, FPM.
- e. Design and actual CFM.

3.8 HYDRONIC SYSTEM BALANCING

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

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1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
- E. Set calibrated balancing valves, if installed, at calculated presettings.
- F. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- G. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- I. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- J. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
- K. For variable flow systems, open or close sufficient valves to simulate design diversity, if applicable, and coordinate with BAS Contractor for setpoint and setting of all bypass valves.

- L. For primary-secondary flow systems, first balance the primary system crossover flow, then balance the secondary system flow.

3.9 HYDRONIC BALANCING DATA

- A. Include the following data in the TAB Reports:

- 1. Pump Data

- a. Identification and location.
- b. Service.
- c. Manufacturer, model, and serial number.
- d. Type drive.
- e. RPM.
- f. Rated and Actual Motor Data
 - 1) HP
 - 2) Phase
 - 3) Voltage
 - 4) Amperage
- g. Discharge and suction pressures and differential pressures (feet).
- h. Design and actual pump head (feet) and GPM.
- i. No flow (discharge valve closed) suction and discharge pressure (feet).

- 2. Equipment Data (air handling unit, chiller, terminal unit, radiation, coils, etc.)

- a. Identification (symbol) and location.
- b. Service.
- c. Manufacturer and, except for coils and radiation and the like, model, and serial number.
- d. Entering and leaving pressures and pressure differential (feet).
- e. Pressure differential across balancing valve (feet)
- f. Design and actual GPM.
- g. Entering and leaving water temperatures.

- 3. Flow Meter Data

- a. Identification (symbol) and location.
- b. Service.
- c. Type of meter.
- d. Manufacturer, model, and serial number.
- e. Pipe size.
- f. Design GPM and meter indication.
- g. Actual GPM and meter indication.

3.10 VIBRATION MEASUREMENT OF ROTATING EQUIPMENT

- A. Measure, and submit report, vibration displacement for all fans and pumps over 3 hp.

- J. For pneumatic control systems, check main control supply-air pressure and observe compressor and dryer operations.
- K. For electric control systems, record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
- L. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves
 - 2. Fan curves
 - 3. Manufacturers' test data
 - 4. Field test reports prepared by system and equipment installers
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page
 - 2. Name and address of TAB firm
 - 3. Project name
 - 4. Project location
 - 5. Architect's name and address
 - 6. Engineer's name and address
 - 7. Contractor's name and address
 - 8. Report date
 - 9. Signature of TAB firm who certifies the report
 - 10. Table of Contents with the total number of pages defined for each section of the report
 - 11. Number each page in the report
 - 12. Summary of contents including the following:
 - a. Indicated versus final performance
 - b. Notable characteristics of systems
 - c. Description of system operation sequence if it varies from the Contract Documents
 - 13. Nomenclature sheets for each item of equipment.
 - 14. Data for terminal units, including manufacturer, type size, and fittings.

15. Notes to explain why certain final data in the body of reports varies from indicated values.
 16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Variable speed controller settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Air System and Hydronic System Balancing Data:
1. Include all test data required for proper system balance and other test data specified elsewhere in this Section. Include all values, design and actual.
 2. Provide all duct traverse readings, including traverse locations marked on drawings.
- G. Vibration Measurement Reports:
1. Date and time of test.
 2. Vibration meter manufacturer, model number, and serial number.
 3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
 4. Diagram of equipment showing the vibration measurement locations.
 5. Measurement readings for each measurement location.
 6. Calculate isolator efficiency using measurements taken.
 7. Description of predominant vibration source.
- H. Instrument Calibration Reports:
1. Report Data:
 - a. Instrument type and make
 - b. Serial number
 - c. Application
 - d. Dates of use
 - e. Dates of calibration

3.13 INSPECTIONS

- A. Periodically visit the site, as appropriate for size of project or as requested by Owner during the installation of the work. At a minimum, visit the site at the following times:
 - 1. After major equipment is set in place and rough-ins are completed.
 - 2. Prior to installation of shaft enclosures.
 - 3. Prior to ceiling installation.
- B. Should any potential or developing problems be discovered relating to accessibility, materials, equipment, or methods being used in the work, and where such problems may adversely affect the TAB work, immediately report these findings in writing to the Architect with recommendations for correction.
- C. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - 1. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the setpoint.
 - 2. Walk through the spaces and observe any excessive noise or vibration from the HVAC system.
- D. Final Inspection:
 - 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, perform a final inspection to verify the following:
 - a. Verify that all balancing devices are marked with final balance position.
 - b. Verify that all holes in ductwork for pitot-tube traverse have been plugged.
 - c. Verify that all insulation removed during TAB work has been replaced.
 - d. Review requirements for follow-up seasonal checks and schedule dates with Owner.

END OF SECTION 01 91 00

SECTION 01 91 13 - COMMISSIONING

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, and other applicable sections, apply to this Section.

1.2 SUMMARY

- A. Employment of Commissioning Agent:
 - 1. For the purposes of this specification, the TAB Contractor will act as the Commissioning Agent. Responsibilities identified herein to be provided by Commissioning Agent shall be understood to be responsibilities performed by the TAB Contractor, in addition to TAB requirements specified elsewhere.

1.3 DEFINITIONS

- A. BAS: Building Automation System.
- B. Commissioning: The process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent (2007 Guideline 1.1 - HVAC Technical Requirements for the Commissioning Process).
- C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- D. TAB: Testing, adjusting, and balancing.
- E. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 REFERENCES

- A. ASHRAE Guideline 1
- B. AABC Commissioning Guideline
- C. SMACNA HVAC Systems Commissioning Manual
- D. LEED Reference Guide

1.5 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that Commissioning Agent meets the qualifications specified in "Quality Assurance" Article.
- B. Document Reviews: Within 45 days of award of contract, submit report of having reviewed all project documents as specified in "Document Reviews" Article.
- C. Commissioning Plan: Within 90 days of award of contract, submit Commissioning Plan and procedures. Include system verification checklists and data sheets to be used for each system and each piece of equipment.
- D. Verification Checklists: Submit completed commissioning system verification checklists and functional performance test checklists organized and indexed by system and subsystem as one package. The results of failed tests shall be included along with a description of the corrective action taken and subsequent successful retest.
- E. Final Report: Provide final Commissioning Report.

1.6 QUALITY ASSURANCE

- A. The Commissioning Agent shall submit evidence of having commissioned at least five projects of similar size and scope within the past five years.
- B. Forms of checklists shall be similar to sample forms published in either the AABC Commissioning Guideline, SMACNA HVAC Systems Commissioning Manual, or other form approved by Owner and/or Architect.

1.7 RELATED WORK

- A. Commissioning is the primary responsibility of the Commissioning Agent, with secondary and support responsibility of the various Contractors as outlined elsewhere in this Section. The commissioning process does not relieve the Contractors from participation in the process or diminish their role and obligations to complete all portions of work in satisfactory and fully operational manner.

1.8 COORDINATION

- A. The commissioning process, in order to be successful, requires the cooperation and coordination of all members of the Commissioning Team. The Commissioning Agent will coordinate directly with each Contractor on the project specific to their responsibilities and contractual obligations relative to the commissioning process.
- B. Installing Contractor responsible for their Work will provide services described in their respective sections of the specifications.

- C. Enlist the aid of Installing Contractor or equipment suppliers, at no cost to Owner, whenever such aid is necessary for the timely and proper performance of the Commissioning work.
- D. Cooperate with Installing Contractor to effect smooth coordination of the commissioning activities with the project schedule.

1.9 PARTICIPANTS AND RESPONSIBILITIES

A. Commissioning Team

- 1. At a minimum, the commissioning team shall consist of representatives of the following:
 - a. Owner
 - b. Architect/Engineer
 - c. Construction Manager
 - d. Commissioning Agent
 - e. TAB Contractor
 - f. Mechanical Contractor
 - g. Plumbing Contractor
 - h. BAS Contractor
 - i. Electrical Contractor
- 2. The Commissioning Agent shall lead the commissioning team and shall be responsible for the overall completion of the commissioning as outlined elsewhere in this section.

B. Commissioning Roles and Responsibilities

- 1. Owner
 - a. Develop and commit to the Owner's Program for the facility and its use.
 - b. Provide written approval, or "sign-off" of basis of design prepared by Architect/Engineer.
 - c. Assign operations and maintenance personnel and schedule them to participate in the various meetings, training sessions, and observation/inspections as follows:
 - 1) Construction phase coordination meeting.
 - 2) Initial owner training session at initial placement of major equipment.
 - 3) Maintenance orientation and inspection.
 - 4) Piping and ductwork test and flushing verification.
 - 5) Procedures meeting for testing, adjusting and balancing.
 - 6) Owner's training session.
 - 7) Verification demonstrations.
 - 8) Functional performance tests.
 - 9) Final review and acceptance meeting.
 - d. Review and approve any changes made to design intent after original sign-off.
 - e. Review and approve Construction Documents prepared by Architect/Engineer.
 - f. Provide qualified personnel for videotaping and editing of training sessions.
 - g. Videotape or photograph construction progress.
 - h. Review and comment on the Commissioning Agent's verification report.

- i. Review and accept the Commissioning Agent's Final Commissioning Report.
2. Architect/Engineer
 - a. Provide documentation of basis of design (Design Intent Document) from the information received from Owner's requirements.
 - b. Provide Contract Documents outlining system design parameters and revisions to the initial basis of design as necessary, after obtaining approval from owner.
 - c. Prepare Contract Documents, including Commissioning Specification.
 - d. Attend construction phase coordination meetings and perform site observations of installation for compliance with the contract documents at periodic intervals during the construction.
 - e. Review Contractor submittals for compliance with the contract documents.
 - f. Review TAB procedures submitted by the TAB Contractor.
 - g. Review system verification checklists and functional performance test procedures submitted by the Commissioning Agent.
 - h. Review TAB report and verification data sheets by system for conformance to the contract documents.
 - i. Review and accept final TAB report.
 3. Construction Manager
 - a. Include costs for commissioning requirements in the contract price.
 - b. After reviewing commissioning activities with Commissioning Agent, prepare commissioning schedule in conjunction with Construction Schedule.
 - c. Coordinate construction of systems and equipment.
 - d. Ensure that installing contractor's performing all commissioning responsibilities.
 - e. Process the following to the Commissioning Agent:
 - 1) Shop Drawings
 - 2) As-Built drawings
 - 3) ASME certificates
 - 4) Certification of installation
 - 5) Manufacturer's operating and maintenance instructions
 - 6) Manufacturer's service contracts and warranties
 - f. Coordinate the installing contractor's participation in the commissioning process.
 - g. Instruct installing contractor's to maintain record as-built conditions.
 - h. Update Commissioning Agent as to progress of construction. Provide notice when systems and/or subsystems are complete and ready for commissioning.
 - i. As system or major equipment is checked, ensure that proper tagging is affixed to equipment, indicating acceptance or corrective action required. Do not make any changes to systems and/or equipment after acceptance, without prior approval from Commissioning Agent.
 - j. Any deviations due to construction or for any other reason should be recorded on the affected data sheet for that system or piece of equipment.
 4. Commissioning Agent
 - a. With the assistance of the Construction Manager, organize and lead the Commissioning Team.

- b. Review the Owner's Program.
 - c. Review the basis of design (Design Intent Document) prepared by Architect/Engineer.
 - d. Review the Contract Documents prepared by the Architect/Engineer.
 - e. Prepare a Commissioning Plan, for each type of system/subsystem, for demonstrating, verifying and documenting that the equipment and systems/subsystems installation, operation and functional performance are in accordance with the requirements of Contract Documents.
 - f. Update Commissioning Plan as project progresses through its various phases.
 - g. Schedule commissioning coordination meetings.
 - h. Prepare system verification and functional performance test data sheets for each equipment/system to be commissioned.
 - i. Review contractor submittals.
 - j. Witness equipment and systems start-up and testing. Ensure that results are documented, including a summary of deficiencies, and included in the Operation and Maintenance Manuals.
 - k. Schedule the Operation and Maintenance training sessions with the Contractors and Owner representatives.
 - l. Submit system verification checklists and functional performance test procedures for review and acceptance by Owner and/or Architect/Engineer.
 - m. Schedule and witness system demonstration of sequence of operation performed by BAS Contractor.
 - n. Provide services of an experienced testing technician.
 - o. Provide detailed checklists data sheets to document verification tests.
 - p. Submit detailed list of test instrumentation with appropriate calibration records to be utilized for verification and functional performance tests. Record data as necessary.
 - q. Conduct verification tests.
 - r. Conduct functional performance tests, including seasonal variation tests, as required.
 - s. Retest as necessary if performance deficiencies are found and corrected.
 - t. Prepare Final Commissioning Report. Include Re-commissioning Manual in Final Report.
 - u. Recommend acceptance of the equipment and systems to the Owner.
5. TAB Contractor
- a. Include costs for commissioning requirements in the contract price.
 - b. Submit TAB procedures for review and acceptance by the Architect/Engineer and Commissioning Agent.
 - c. Perform TAB work specified in Section 01 91 00.
 - d. Attend commissioning coordination meetings scheduled by the Commissioning Agent.
 - e. Participate in training sessions as scheduled by the Commissioning Agent.
 - f. Provide notice of the completion of TAB work and submit final TAB report.
 - g. Participate in verification tests, which will consist of repeating any selected measurement contained in the TAB report where required by Commissioning Agent.
6. Mechanical Contractor

- a. Include the costs of commissioning requirements in the contract price.
- b. Shall support the Commissioning Agent in the completion of data on system verification checklists.
- c. Process the following to the Construction Manager:
 - 1) Shop drawings
 - 2) As-built drawings
 - 3) ASME certificates
 - 4) Certificate of installation
 - 5) Manufacturer's operating and maintenance instructions
 - 6) Manufacturer's service contracts and warranties
- d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers and the BAS Contractor.
- e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.
- f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.
- g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.
- h. Provide notification a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
- i. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.
- j. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.
- k. Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup TAB, and task completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.
- l. Attend initial O&M staff training session.
- m. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
- n. Update drawings for as-built condition and review with the commissioning team.
- o. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.
- p. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.

- q. Provide written notification that the following work has been completed in accordance with the Contract Documents and the equipment, systems and subsystems are operating as required.
 - 1) HVAC equipment including all fans, air handling units, ductwork, dampers, terminals and all Division 23 equipment.
 - 2) Refrigeration equipment, pumping systems and heat rejection equipment.
 - 3) Fire-stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - 4) Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.

7. Plumbing Contractor and Fire Protection Contractor

- a. Include the costs of commissioning requirements in the contract price.
- b. Shall support the Commissioning Agent in the completion of data on system verification checklists.
- c. Process the following to the Construction Manager:
 - 1) Shop drawings
 - 2) As-built drawings
 - 3) ASME certificates
 - 4) Certificate of installation
 - 5) Manufacturer's operating and maintenance instructions
 - 6) Manufacturer's service contracts and warranties
- d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers.
- e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.
- f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.
- g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.
- h. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.
- i. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.
- j. Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe system testing, flushing and

cleaning, and task completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.

- k. Attend initial O&M staff training session.
- l. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
- m. Update drawings for as-built condition and review with the commissioning team.
- n. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.
- o. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.

8. BAS Contractor

- a. Include costs for commissioning requirements in contract price.
- b. Support Construction Manager to complete data on checklists.
- c. Process the following to the Construction Manager:
 - 1) Shop drawings
 - 2) As-built drawings
 - 3) Any approval letters from authorities
 - 4) Provide paid-in-full service contract with cost for second year
- d. Training and instruction of Owner's personnel.
- e. Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
- f. Review and confirm in writing that proper safeties and interlocks are included in design.
- g. Ensure the proper sizing of control valves and actuators, based on design pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to mechanical engineer.
- h. Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to mechanical engineer.
- i. Ensure the proper selection of sensor ranges, and include data with submittal to mechanical engineer.
- j. Attend commissioning meetings scheduled by the commissioning team or Commissioning Agent.
- k. Inspect, check and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
- l. Integrate installation and programming scheduling with construction and commissioning schedules.
- m. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
- n. In conjunction with the mechanical contractor, demonstrate system performance to the commissioning team including all modes of system operation (e.g., occupied, unoccupied, emergency) during the functional performance tests. If improper

functionality, incomplete work, or other deficiencies affecting system performance are discovered, the commissioning team will stop the functional performance tests.

- o. Provide control system technician to assist during system verification and functional performance testing.
- p. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Make available, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB and commissioning procedures.

9. Electrical Contractor and Fire Alarm Contractor

- a. Include the costs of commissioning requirements in the contract price.
- b. Shall support the Commissioning Agent in the completion of data on system verification checklists.
- c. Process the following to the Construction Manager:
 - 1) Shop drawings
 - 2) As-built drawings
 - 3) Electrical certificates from electrical inspection agency
 - 4) Manufacturer's certification and warranties of system operation
 - 5) Test reports as required by specifications
 - 6) UL meter label certificates
 - 7) Manufacturer's operating and maintenance instructions
- d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers.
- e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.
- f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.
- g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.
- h. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.
- i. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.
- j. Prepare preliminary schedule for electrical system orientation and inspections. O&M manual submission, training sessions, and task completion for use by the

Commissioning Agent. Update schedule as appropriate throughout the construction period.

- k. Attend initial O&M staff training session.
- l. Conduct electrical system orientation and inspection at the equipment placement completion stage.
- m. Update drawings for as-built condition and review with the commissioning team.
- n. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.
- o. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.

1.10 SYSTEMS TO BE COMMISSIONED

A. The following Mechanical/HVAC systems are to be commissioned:

- 1. Air handling units and associated return fans
- 2. Terminal VAV boxes
- 3. Exhaust fans
- 4. Computer Room A/C units
- 5. Chiller equipment and pumps
- 6. Boiler equipment and pumps
- 7. Building Automation System

B. The following Mechanical/Plumbing systems are to be commissioned:

- 1. Domestic water supply pumps
- 2. Domestic hot water heaters
- 3. Sump pumps

C. The following Electrical systems are to be commissioned:

- 1. Lighting control systems including daylight dimming controls
- 2. Emergency Generator
- 3. Uninterruptible Power Supply (UPS) systems
- 4. Manual and automatic transfer switches
- 5. Lightning protection system

D. The following Fire/Life Safety systems are to be commissioned:

- 1. Fire alarm system
- 2. Fire sprinkler system
- 3. Fire pump
- 4.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DOCUMENT REVIEWS

A. Owner's Program

1. Obtain and review the Owner's program requirements document.

B. Basis of Design (Design Intent Document)

1. Obtain and review the basis of design document prepared by the Architect/Engineer.
2. Compare scope of work identified in the basis of design to Owner's program requirements. Prepare written statement whether basis of design meets the intent of the Owner's program. Clearly note any significant deviations.

C. Contract Documents

1. Obtain and review latest submission of all Contract Documents including Addenda and Bulletins.
2. Compare scope of work identified on Contract Documents to basis of design. Prepare written statement whether the Contract Documents meet the intent of the basis of design. Clearly note any significant deviations.
3. Review documents for any specific condition or layout that will prevent commissioning from being completed, such as equipment accessibility and maintainability, installation clearances and available space, and coordination of other trades. Notify Architect/Engineer of such instances in a timely manner.
4. When Commissioning Agent is retained prior to issuance of final Contract Documents, review preliminary Contract Documents issued for progress review as outlined above.

D. Contractor Submittals

1. Obtain and review all submittal drawings, specifications and equipment vendor submittals for any deviations from design intent, either as shown on Contract Documents and/or basis of design documents. Notify Architect/Engineer of any potential deviations from design intent.
2. Review all drawings, specifications and equipment vendor submittals for any conflicts or design details that will hinder or prevent the systems from being balanced, commissioned and maintained. Notify Architect/Engineer of any problem areas of concern.

3.2 COMMISSIONING PLAN

A. Prepare a Commissioning Plan (or Agenda) that details the entire commissioning process. The plan shall include as a minimum:

1. Project Overview, Goals and Objectives
2. Systems to be commissioned

3. Definitions
4. A roster of the Commissioning Team with contact information
5. Roles and Responsibilities
6. Procedures for project communication
7. Commissioning process
8. Preliminary commissioning schedule

3.3 SYSTEM VERIFICATION CHECKLISTS

- A. Prepare detailed installation and functional performance criteria checklists for each type of equipment and for each type of system/subsystem. Provide individual data sheet for each piece of tagged equipment.
- B. Data sheets and checklists shall be in tabular format with columns and rows to be filled in by the Commissioning Agent for: Project identification, equipment or system/subsystem identification, installation checklist and functional performance test checklist. Form of data sheets and checklists to be similar to sample forms included in the AABC Commissioning Guideline, SMACNA HVAC Systems Commissioning Manual, or other as approved by Owner and/or Architect/Engineer.

3.4 PRE-COMMISSIONING ACTIVITIES

- A. After final review of the Commissioning Plan and system verification checklists, schedule a pre-commissioning meeting not less than 90 days prior to scheduled start of commissioning work for a detailed review of the Commissioning Plan with all participants in the commissioning process.
- B. Equipment and systems are expected to be in full compliance with the design intent by the start of the commissioning phase. Do not proceed with the commissioning work for any specific piece of equipment/system/subsystem until notified by the installing contractor that such piece of equipment/system/subsystem is ready for commissioning.
- C. Presence of obviously incomplete work shall be reported to the installing contractor and commissioning shall not proceed until the installation is complete. Equipment exhibiting problems during functional performance testing relating to lack of completion or noncompliance with the design intent shall require re-commissioning at the expense of the installing contractor.
- D. Complete operational readiness of the heating, ventilating and air-conditioning system also requires that the following be accomplished:
 1. Cleaning, flushing and chemical treatment of piping, ductwork and all system equipment has been carried out in accordance with the requirements of the specifications. Reports shall be submitted, and reviewed and accepted before this process is considered complete.
 2. Pressure testing of piping and all supply, return and exhaust ductwork has been carried out. Reports shall be submitted, and reviewed and accepted before this process is considered complete. Complete test reports prior to initial start-up.

- E. Testing, adjusting and balancing work must be performed prior to commissioning. Operational tests should also be conducted on equipment, duct, piping and control systems to verify that pressures and flow rates meet design requirements.
- F. Building Automation System controls testing and calibration should begin concurrent with, and completed subsequent to, the testing, adjusting and balancing work. Commissioning Agent shall observe and verify all start-up and calibration activities as part of the ongoing commissioning process.

3.5 COMMISSIONING ACTIVITIES

- A. Implement Commissioning Plan in conjunction with the installing contractors, and in the presence of an authorized representative of the Owner. Conduct system verification checks and functional performance tests by filling out the data requested using the approved checklists.
- B. As a minimum, perform the following for each piece of equipment and each system/subsystem:
 - 1. Document and verify that each piece of equipment and that each system has been properly installed in accordance with the Contract Documents and manufacturer's written installation instructions.
 - 2. Document and verify that piping systems have been properly connected to each piece of equipment and have been properly tested and cleaned in accordance with the requirements of the Contract Documents.
 - 3. Document and verify that duct systems have been properly connected to each piece of equipment and air delivery/exhaust/return device and have been properly tested and cleaned in accordance with the requirements of the Contract Documents.
 - 4. Document and verify that Electrical work for equipment and systems to be commissioned has been properly installed and tested in accordance with the requirements of the Contract Documents.
 - 5. Document and verify that each piece of equipment has been placed into operation in accordance with manufacturer's written installation instructions.
 - 6. Document and verify that adjusting, balancing and system testing has been properly done in accordance with requirements of this section prior to functional performance testing. Make on-the-spot checks as deemed appropriate during functional performance testing.
 - 7. Document that operation and maintenance instructions and submittal data have been provided in accordance with the requirements of the Contract Documents.
 - 8. Document and verify that applicable code authority inspections and approvals and all construction certificates have been provided in accordance with the requirements of the Contract Documents.
 - 9. Document and verify the functional performance testing of each piece of equipment and each system and subsystem. Document controls and instrumentation as specified hereinafter.
 - 10. Document warranty start and end dates.
- C. Documentation of Controls and Instrumentation
 - 1. Document and verify that the controls and instrumentation work has been properly installed and tested and is performing in accordance with the requirements of the Contract Documents.

2. Functional performance testing shall be accomplished for each control device. Actuators shall be stroked for complete length of travel. All relays and adapters shall be checked for proper operation. Controllers shall be checked for proper action. All system interlocks, interconnections, smoke damper and safety devices shall be checked for proper function.
3. All control settings shall be verified by comparing actual input and output measured values to calculated values.

D. Owner Training Sessions

1. The Commissioning Agent shall facilitate all owner-training sessions. These sessions shall cover the operation and maintenance of each piece of equipment and system. Each contractor shall provide the training for his or her area of responsibility. The entire program shall be videotaped for future use by owner.

E. Seasonal Functional Performance Tests

1. The Commissioning Team shall provide an off-season functional performance tests for all HVAC systems. The intent of this test shall cover the ability of the system to maintain performance during the opposite season from the original commissioning season. The Commissioning Agent shall prepare a seasonal commissioning test report.

3.6 FINAL COMMISSIONING REPORT

- A. A Commissioning Report must be prepared and presented to the Owner after all testing and system demonstration is complete.
- B. The Commissioning Report must include the following, as a minimum:
 1. Certification that building systems meet the design intent.
 2. Certification that building systems meet the Contract Documents.
 3. Completed system verification checklists ensuring proper installation.
 4. Completed functional performance tests checklists ensuring proper operation.
 5. Operation and maintenance (O&M) documentation.
 6. Verification that Owner has received proper operator training.
- C. The Final Commissioning Report shall be 8 ½ by 11 formats; contained in a hard cover, three ring binder(s), separated into sub-divided sections each tabbed and indexed in a table of contents. Drawings larger than 8 ½ by 11 shall be folded and inserted into clear plastic protective folders with drawing content clearly visible, single protective folder for each drawing. Drawing label shall be affixed to protective folder in order to reserve proper placement in the binder. Include the following:
 1. Cover sheet
 2. Table of Contents
 3. Project Description
 4. Project Team Contact Information
 5. Basis of Design document
 6. Copy of Commissioning Specification
 7. Commissioning Plan

8. Copy of Building Automation System Sequences of Operation
9. Latest approved BAS shop drawings
10. Listing of all approvals, inspections, certification required by local authorities having jurisdiction including copies of all letters, affidavits, certificates, etc.
11. Meeting minutes from commissioning meetings
12. Commissioning Schedule
13. Specification and calibration certificates for all equipment being used during commissioning
14. Relevant certificates relating to work items such as pressure testing, system flushing, etc.
15. All equipment start-up and test certificates
16. Shop drawing submittal cut sheets for each item in the system
17. Startup Plan
18. Record of system deficiencies and record of correction and acceptance of noted deficiencies
19. Final version of functional performance test procedures
20. Completed commissioning checklists
21. Letters of certification from all members of the Commissioning Team that all systems have been properly commissioned otherwise giving clear definition of any deferred commissioning and deviation from Final Commissioning Plan
22. Re-commissioning Plan
23. O&M Manuals (Can be an appendix to the Final Commissioning Report)

END OF SECTION 01 91 13

NC State University Design and Construction Guidelines

Division 01 NC State's Requirements

[Designer shall incorporate this document into the specification in its entirety.]

1.0 Purpose

- A. The following guidelines apply to North Carolina State University's ("NC State") requirements specific to the needs of NC State. It is the goal of NC State to identify specific needs relevant to working on a public university campus that will help the Contractor gain more knowledge and be fully aware of NC State's expectations while working on campus.
- B. References include the following:
 - 1. NC State University Design and Construction Guidelines – [Division 01 Contractor Safety Guidelines](#)
 - 2. NC State Transportation's Contractor Parking Policies: <http://www2.acs.ncsu.edu/trans/parking/specialty.html>
 - 3. NC State University, Environmental Health and Public Safety, Fire Protection Department Hot Work Permit Procedures. Contractor shall access the following website to obtain hot work permits: http://www.ncsu.edu/ehs/fire/hot_work.htm

2.0 General Requirements

- A. The Owner's Representative - NC State will designate a Project Manager to act as the Owner's Representative in all matters pertaining to construction contracts. All official contacts, decisions, directions, problem resolution, coordination and other liaison activities required from NC State will be through the Project Manager. This requirement does not modify the responsibilities of the Designer as stated in the General Conditions of the Contract.
- B. Contractor, at its expense, shall conduct a background check for each of its employees, as well as for the employees of its subcontractors, who will perform any function or activity under this Agreement. NC State may withhold consent for any of Contractor's employees to be placed on a NC State assignment at its sole discretion.
- C. Behavior policy - All construction personnel shall be respectful of all members of the NC State community. Any incidents of disrespect, verbal abuse, threatening statements, unwelcome comments, unwelcome interaction or any form of harassment from any construction personnel toward any member of NC State community is strictly prohibited. Any such act shall constitute sufficient cause for NC State to remove any individual permanently from the project and all NC State property. In addition, any of the Contractor(s) project personnel who ignore or refuse to take action on any requirements of the contract documents or ignore or refuse to take immediate action to correct any endangerment to the health and safety of the public (as solely determined by NC State)

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Division 01 NC State's Requirements

shall be permanently removed from the project and NC State property. If in the sole determination of NC State it is in the best interest of the project and NC State to have any of the Contractor(s) personnel removed from the project, then the Contractor shall do so upon request by NC State. Such actions taken by NC State shall not constitute grounds for a delay claim. NC State will not be responsible for any delays caused to the project due to any individual being removed from the project by NC State.

- D. Contractor Safety expectations while on this NC State project:
1. Reference **Division 01 – Contractor Safety Requirements** for items identified in this section.
 2. Designation of Competent Persons as noted in Section 4.0/C shall be included in the jobsite contact list.
 3. Submit a Contractor Site-Specific Safety Plan (SSSP) to the NC State Project Manager (reference Contractor Safety Guidelines 4.0/I).
 4. The Safety Representative, as defined by Section 4.0/D must complete, at a minimum, the OSHA Construction Safety Course as defined in Section 4.0/D/1/b.
- E. Protection of Work, Property, and Public:
1. The single prime Contractor, Construction Manager at Risk or Project Expediter (on a multi prime project), henceforth referred to as “the Contractor,” shall ensure that campus streets connecting to the project are protected from mud, sand, and stones/gravel. Streets and adjacent property sites shall be kept free from run-off, litter and/or debris in any form from the project site. Mud, litter and/or debris from the construction site that appears on adjacent property sites shall be removed immediately. All mud collected on vehicle tires shall be removed before leaving the construction area. Should any mud or debris from the project site collect on the streets, it shall be removed immediately to prevent any hazards to vehicular or pedestrian traffic as well as from entering the storm sewer system. In any event, all streets and property sites adjacent to the project site shall be cleaned of construction related debris, dust, litter and mud daily. The Contractor, in the preparation of bids, shall account for the daily cleaning of adjacent streets and property sites. The Contractor(s) is prohibited from discharging any waste products from concrete trucks or from concrete coring work, or any other unsuitable materials, fluids or other products on the site or into the storm sewer system. Should the Contractor fail to comply with these requirements, NC State reserves the right, with twenty-four (24) hours prior notice to the Contractor, to clean and or remove mud, trash, litter, debris or any unauthorized discharge from the project site and/or the adjacent streets or properties. In such case, the cost of the cleaning and/or removal or mobilization for cleaning and/or removal shall be deducted from the Contractor's contract.

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Division 01 NC State's Requirements

2. The Contractor shall repair any damage (including but not limited to: scratches, cuts, dings, holes, track marks, etc.) of any kind made to existing hardscapes (asphalt/concrete roadway and drives, curb and gutter, brick sidewalks, etc.) by heavy equipment or other causes. Repairs shall consist of a complete, full depth removal and replacement of the affected asphalt, concrete or brick hardscapes at the Contractor's expense, or as otherwise determined by the Owner, to include the full width of the road, parking lot, walk or curb that is affected. The Contractor is strongly encouraged to be mindful of this while working around and off-loading equipment in areas of new construction adjacent to existing areas, which are not in the original scope of work to be renovated or repaved. In general, equipment shall be off-loaded inside of assigned staging areas, and the Contractor shall take protective measures as needed, including protective plywood or other means to prevent damage of the hardscape surface. The slightest damage will result in full hardscape replacement at the Contractor's expense.
 3. Blasting on NC State property is prohibited.
 4. Each Contractor doing excavation work is responsible for locating all existing underground utilities prior to commencing excavation. The Contractor shall be responsible for the associated cost of any utility interruption and repair due to his excavation if utility location was not requested, location procedures performed and followed prior to commencing excavation. The Contractor shall immediately notify NC State and restore the service of any utility disrupted due to excavation or any Contractor action whatever the circumstance. NC State reserves the right to immediately restore the service of any utility disrupted due to actions of the Contractor and deduct the cost of such restoration from the Contractor's contract.
 5. For emergency situations during construction, the Contractor shall furnish NC State with the names, pager numbers, and telephone numbers (day and night) of the Contractor's project manager and superintendent prior to beginning work. The numbers shall remain current or be updated as required for the duration of the project. The Contractor shall contact NC State via cell phone immediately in the event of an emergency. NC State will only provide security, as it deems prudent and necessary for its own protection. The Contractor shall be responsible for the security and safety of the project within the project limits. NC State must approve any "watchman" service instituted by the Contractor.
 6. NC State will conduct normal operations during the duration of the project. The Contractor shall coordinate with NC State to minimize any disruptions to the functions of NC State.
- F. Working Hours - The Contractor may establish a work schedule of his own choosing. The Contractor shall submit to NC State and to the Designer his regular daily work

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Division 01 NC State's Requirements

schedule and shall notify NC State in writing one week in advance of any deviations from the schedule. There are no restrictions regarding work hours. NC State reserves the right to limit the Contractor's activities when they conflict with NC State operations. These operations include but are not limited to the following: examination periods (typically for two weeks in December and two weeks in May), graduation (typically for one weekend in December and May), athletic events, and student move in/move out days. During these times, the Contractor may be required to cease all construction activities, limit activities to on-site only, modify working hours or restrict noise-making activities as determined by NC State.

- G. Contractor Daily Reports - The Contractor shall keep construction daily reports and provide, at NC State's request or on a minimum weekly basis, copies of these daily reports. The Contractor shall either use the company's standard daily report or use a template provided by NC State. The daily report shall at a minimum include the following information:
1. Project name, SCO Project ID#, NC State Project #
 2. Report #
 3. Date and time report was generated
 4. Weather data: overhead conditions, precipitation (if so, how much), temperature (high and low), impact on progress
 5. Document Daily Safety Briefing (refer to Contractor Safety Guidelines 4.0/E)
 6. Report Daily Safety Inspections (refer to Contractor Safety Guidelines 4.0/F)
 7. Sediment and erosion control
 8. Work performed (include all major trades)
 9. Number of workers on site
 10. Major equipment deliveries
 11. Major equipment working on site
 12. Difficulties encountered that may cause delay
 13. Days of no work and reason
- H. Meetings - The contractor shall at a minimum conduct weekly coordination meeting to review construction progress and any issues that need to be resolved. Contractor shall invite NC State and Designer as well as any required subcontractors.
- I. Inspection of the work - NC State will conduct the following inspections, as applicable, which shall be included in the construction schedule: in-wall inspections, above ceiling inspections, generator test, fire pump test, fire sprinkler main drain tests, pre-final inspections, 100% test of the fire detection and alarm system, third-party materials testing/special inspections/commissioning and a final inspection for project acceptance. Any inspections that are not satisfactory shall be repeated at no cost to NC State and shall

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not be cause for a time extension. All inspections will be conducted by NC State at the same time as the Designer's inspection and a punch list generated. The Contractor shall give the Designer and NC State a minimum of fourteen (14) calendar days prior notice that the systems have been verified by the Contractor to be complete, fully functional and ready for inspection. The following general guidelines apply to the above ceiling inspections:

1. The systems must be complete, including but not limited to controls, insulation, labeling, tagging, fireproofing, fire stopping, wiring, light fixtures installed, and all piping in place.
2. Ceiling grid may be installed as required, framing for hard ceilings shall be in place, and access door locations shall be framed and noted.

Under no circumstance shall any ceiling or wall area be covered prior to the above ceiling inspection. All punch list items generated from the inspections shall be completed by the Contractor and verified by the Designer and NC State. Any re-inspection costs, including but not limited to Designer, NC State, State Construction Office (SCO) or third party personnel, that result from punch list items not being 100% complete shall be at the expense of the Contractor.

- J. Use of the Premises - Parking is extremely limited at NC State. Parking for personal vehicles on campus is not provided. Contractors must limit parking of company vehicles and storage of materials to within the limits of the construction site and staging area. The Contractor is required to follow NC State Transportation's Contractor Parking Policies (see web link on page one of this document).
- K. Utilities - It is imperative that all campus utilities and all other campus services are maintained at all times except for scheduled interruptions. Required utility interruptions shall be scheduled with and requested through NC State at least fourteen (14) days in advance for minor outages and thirty (30) days in advance for major outages. NC State is the sole determiner of the utility outage being major or minor. Major outages include but are not limited to those that affect an entire floor of a building, all of a building, all or parts of several buildings, all or parts of an area, and any high voltage outage. No utility interruption, regardless of the advance notice given, shall be undertaken without expressed, specific approval from NC State. If requested by NC State, utility outages shall be performed after hours and/or at night, or over the weekend, or during holidays. No extra payment will be made for such work. NC State personnel will perform certain activities in connection with utility outages such as operating existing electrical switches, turning existing water and steam valves, placing existing building systems back in operation, operating existing fire alarm systems, etc. NC State will bear the expense of the work of their personnel. When the Contractor requires an additional or extra outage to complete their work because of a shortage of or improper materials, shortage of labor, poor coordination, failure to finish the work during the outage scheduled length of time, the Contractor will pay all expenses incurred for NC State's services for an additional

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outage(s). No service disruptions shall take place until barricades (if applicable) and signs are in place to notify and/or protect the public. Barricades must be maintained at all times and signs shall be neat and legible, hand-made signs are not acceptable. Signs for utility outage notice shall be written and placed as directed by NC State seven (7) workdays prior to the outage. NC State may determine the utility service cannot be interrupted for the length of time or frequency requested by the Contractor. In such case the Contractor shall include in his bid provisions for temporary utility services for the duration of the outage at no cost to NC State.

- L. Survey of New and Existing Sub-surface Utilities - Perform field location surveys of new utilities installed as well as existing utilities uncovered during the construction phase. Conventional survey standards are to be utilized during the collection of field data. All work shall be performed by qualified personnel under the supervision of a Professional Land Surveyor. Accuracy Standards: horizontal and vertical location shall be +/- 0.25'. Survey (NAD83-North Carolina State Plane Coordinates) shall tie to NC State's horizontal & vertical control monuments.
1. Utility Drawing Set (Hard Copy)
 - a) Cover Sheet - All projects require a cover sheet with the following information -
 - (1) NC State Project Name
 - (2) NC State Project Number
 - (3) NC State Building Name (s)
 - (4) NC State Building Number or Utility Zone Number (s)
 - (5) Project Phase (i.e. Schematic Design, Design Development, 100% Bid Documents, or Record Set)
 - (6) Sheet Name with discipline letter preceding sheet number (i.e. A100 for an Architectural Plan).
 - (7) Drawing Index
 - (8) Site Map
 - (9) For interior renovations, a hatched key plan indicating the extent of work
 - b) Drawing Sizes – sheet sizes shall not exceed 36" x 48" and shall not be less than 24" x 36" in size.
 - c) Include licensing seal and certification on 100% bid documents and record set documents.
 2. Utility Drawing Set (Electronic Copy)
 - a) Format shall be .pdf.
 - b) Submission is required at each project phase.
 - c) File naming shall be as follows:

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- (1) Typical file naming shall be as follows -
bldg #_ncsu project number_date_phase.pdf or
utility zone #_ncsu project number_date_phase.pdf
 - (2) Example: 799Z_201300001_10-31-12_sd.pdf
 - (3) For projects with multiple buildings or utility zones, the lowest number shall be used in file name.
3. Electronic Source CADD Files (Record Set and first Construction Document Submittal)
 - a) Electronic files of all drawings shall include source drawings, font libraries, custom line styles/codes, plot style tables and other digital CADD related information.
 - b) The files shall be in AutoCAD .dwg format; the AutoCAD version shall be within the last 2 years of the current release.
 - c) Drawings shall be drawn at a scale of 1 to 1 in model space. Interior spaces shall be in Architectural inches. Exterior space shall be in US survey foot.
 - d) For exterior projects use NAD 83 North Carolina State plane coordinates.
 - e) All external references shall be bound as inserts or inserted directly as a block into the drawing. X-refs of any kind are not acceptable.
 - f) Remove licensing seals from drawing files.
 - g) Drawings shall be purged and audited.
 - h) Submission shall not include backup .bak files or .zip files.
 - i) Site, Civil, and Survey drawings shall use the NC State mapping drawing template, which includes NC State standard layers, linetypes and block symbols. The current version can be downloaded at www.ncsu.edu/facilities/con_guidelines/NCSU_CIV-SRV_TEMPLATE.dwg
4. Utility Submission
 - a) Hard Copy - The Drawing Set shall be submitted on bond paper.
 - b) Electronic Files for the Record Drawing Set and Source CADD Files shall be accompanied by a transmittal with a listing of the included documents and the following information:
 - (1) NC State Project Number
 - (2) NC State Project Name
 - (3) NC State Building Number(s)
 - (4) NC State Building Name (s)
 - (5) NC State Project Manager's Name and Phone Number

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- (6) Submitting Professional's Name and Address
- c) Electronic Files shall be submitted on a CD or DVD
 - (1) A .pdf file of the transmittal shall be included on each disk.

- M. The following outline lists the utilities to be located and the data to be collected. Photographs shall be at a minimum resolution of 2200 x 1700. Digital photographs can be submitted in TIFF, JPG, or RAW file formats. File naming shall be all lower case text. File naming shall be as follows: bldg#_ncsu project number_util_photo#.file extension. For example: 135_201300001_util_1.jpg
 - 1. Steam Tunnel and Lines
 - a) Location and elevations of the tunnel slab and top of tunnel centerlines.
 - b) Location and size of steam and condensation pipes in the tunnel, including changes in directions, expansion loops and anchors.
 - c) Top of pipe of any direct buried steam and condensation pipes, including changes in directions, expansion loops and anchors.
 - d) List the construction material for the tunnels.
 - e) Provide digital photographs of the tunnel, piping and expansions areas.
 - 2. Water Lines - (Domestic, Fire Main, Chilled, Hot Water, & Reuse Waterlines)
 - a) Locations, size and elevations at the top of installed water lines, including changes in direction.
 - b) Locations of valves and a valve type designation, meters, fire department connections, post indicator valves, hydrants, reducers, manholes, and backflow device.
 - c) Provide digital photographs of bends and valves.
 - 3. Electric and Communication Duct Banks and Direct Buried Conduit
 - a) Location and elevations of the duct bank top and bottom.
 - b) Location and elevations of conduit runs in the duct bank.
 - c) Location and elevations of any direct buried conduit or concrete duct bank.
 - d) Location and elevations of manhole rims, transformers, pedestals, switches, poles, overhead lines, junction boxes, panels, generators, and meter boxes.
 - e) Provide digital photographs of the tunnel and conduit configuration.
 - 4. Gas
 - a) Location and elevations of top of pipe and any change in direction.
 - b) Location and elevations of meters, pressure reducing stations, test stations, generators, and valves.

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5. Storm and Sanitary Sewer
 - a) Provide invert elevations for incoming and outgoing piping at manholes.
 - b) Provide top elevation of manhole cover.
 - c) Note if manhole rims are in the center of the structure or not. Measure the offset, pipe sizes, material types and the direction of the flow.
 - d) Provide digital photographs of structures.
 6. Existing Utilities
 - a) Locate and provide elevations consistent with new utility requirements of any existing utilities exposed during excavation of trenches for new utilities.
 - b) Provide digital photographs of the crossing or conflict.
 7. Deliverables for Surveys
 - a) The subsurface location data and platting shall be continuous throughout the project.
 - b) All data and plats are due to NC State within two-weeks of the backfilling of utilities or completion of the associated construction task.
- N. Traffic Movement and Interruptions - Road and sidewalk blockages shall be scheduled fourteen (14) days in advance and made only after NC State has approved them. Appropriate detours shall be planned, subject to approval by NC State, giving consideration to the handicapped access. No excavations shall take place prior to placing proper barricades, lighting, and other devices as shall be required. The Contractor shall install warning signs, barricades and detour information signs to maintain traffic flow as directed by NC State. If required, flagmen shall direct traffic around the construction area or detour area. Contractors are reminded of the presence on campus of handicapped students, staff and faculty. All barricades, temporary walkways, excavations, and stockpiled materials shall be placed and/or constructed in such a manner as to accommodate, adequately warn, and protect this segment of the campus population. The Contractor shall make requests for approval for any street, alley, driveway or any access way to be closed at least fourteen (14) work days prior to the date for the desired closing. The Contractor shall close no street, alley, driveway or access-way without prior approval by NC State. Pedestrian and vehicle traffic way-finding around the construction limits must be maintained in a clean and safe condition at all times.
- O. Fire Alarm Shutdowns - When requesting fire alarm shutdowns to support construction activities, the contractor shall provide advanced notice as determined by the NC State Project Manager. The contractor shall also be required to reimburse NC State for all costs associated with the fire alarm shutdown as follows:
1. During normal business hours (Monday – Friday, 7:00 AM – 5:00 PM): \$75.00 per disconnect and \$75.00 per reconnect for a total of \$150.00.

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2. After normal working hours (Monday – Friday, 5:01 PM – 6:59 AM; Saturday – Sunday): \$150.00 per disconnect and \$150.00 per reconnect for a total of \$300.00.
 3. If at any time the fire alarm system is not in operation after normal working hours then the contractor shall be required to employ a Fire Watch for the unprotected portion of the building, using NC State Fire Marshal's approved Fire Watch company (hourly rates vary but should not exceed \$35.00 per hour.)
- P. Hot Work Permits - When the Contractor is performing work that produces heat, flame, or sparks on or in an existing building or other structure the Contractor is required to obtain a "hot work" permit from NC State Environmental Health and Public Safety, Fire Protection Department. The department's requirements for the hot work program and permit can be found at the web link on the first page of this document.
- Q. Cleanliness and Site Maintenance - The Contractor(s) shall be responsible for keeping the project limits area, the project site, and the project itself clean and free of accumulated construction debris and trash. To that extent, the Contractor(s) shall be responsible for cleaning their work areas weekly at a minimum and the proper disposal of their construction debris and trash. The construction site and staging areas shall be cleaned as previously noted; however, should trash, litter or debris from the project site migrate to any adjacent campus areas it shall be removed immediately. Grass in the construction site shall be mowed as often as required to maintain a neat appearance or as requested by NC State but in no case less than once per month. Should the Contractor(s), in the sole judgment of NC State fail to comply with these requirements, then NC State reserves the right to proceed with cleaning within the project limits area, immediate project site, the interior of the project or, if applicable, the adjacent areas to the project as it deems necessary. The cost of the cleaning and/or the mobilization cost of cleaning will be deducted from the Contractor(s) contract.
- R. Storage of construction materials and equipment - Storage of construction materials and equipment shall be limited to the staging area. Should the Contractor fail to remove any material stored or equipment outside the staging area within twenty-four (24) hours of notification received from NC State, NC State shall have the right to remove and dispose of such materials from the campus. NC State will deduct the cost of such removal and disposal from the Contractor(s) contract. The offending Contractor(s) shall be responsible for any delay to the project resulting from NC State having to remove and dispose of such materials or equipment.
- S. Construction site - A construction fence shall be installed around the perimeter of the project limits. The fence shall be constructed of heavy-duty chain link material, have a minimum height of six feet and shall have a continuous top tubular rail. Swing gates shall be included at every access to the enclosed area. The fence shall have an integral visual barrier or shall have shading type material applied and maintained for the duration of the

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project. Locks for the gates shall be interlocked with a padlock provided by NC State in order to allow access by NC State or other emergency personnel in case of an emergency.

- T. Inspection and Audit - Contractor's "records" shall upon reasonable notice be open to inspection and subject to audit and/or reproduction during normal business working hours. An NC State representative or an outside representative engaged by NC State may perform such audits. NC State or its designee may conduct such audits or inspections throughout the term of this contract and for a period of three years after final payment or longer if required by law.
1. Contractor's records as referred to in this contract shall include any and all information, materials and data of every kind and character, including without limitation, records, books, documents, subscriptions, recordings, agreements, purchase orders, leases, contracts, commitments, arrangements, notes, daily diaries, superintendent reports, drawings, receipts, vouchers and memoranda, and any and all other agreements, sources of information and matters that may in NC State's judgment have any bearing on or pertain to any matters, rights, duties or obligations under or covered by any Contract Document. Such records shall include (hard copy, as well as computer readable data if it can be made available): written policies and procedures; time sheets; payroll registers; payroll records; cancelled payroll checks; subcontract files (including proposals of successful and unsuccessful bidders, bid recaps, etc.); original estimates; estimating work sheets; correspondence; change order files (including documentation covering negotiated settlements); back charge logs and supporting documentation; invoices and related payment documentation; general ledger entries detailing cash and trade discounts earned; insurance rebates and dividends; and any other Contractor records which may have a bearing on matters of interest to NC State in connection with the Contractor's dealings with NC State (all foregoing hereinafter referred to as "records") to the extent necessary to adequately permit evaluation and verification of:
 - a) Contractor compliance with contract requirements,
 - b) Compliance with NC State's business ethics policies, and
 - c) Compliance with provisions for pricing change orders, invoices or claims submitted by the Contractor or any of his payees.
- U. Changes in the Work - Overhead shall also include all general conditions of the contract and all general requirements such as project management, scheduling, home office expense, engineering and layout, reproduction expenses, shop drawing processing and coordination, supervision, coordination, small tools, all vehicle expenses, temporary facilities, safety provisions, as built drawings, estimating, and general overhead.
1. The change order cost break down shall include: labor (number of hours and \$/hr) and material (quantity and \$/unit), including such breakdowns for work

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performed by the general contractor and all subcontractors. Unit prices shall only be allowed as stipulated in Article 19 of the contract General Conditions. Cost extensions shall be clearly shown for the labor and material prior to any mark-ups. The cost extensions shall be added into a labor and material subtotal. The labor shall then show a percentage for labor burden, while the materials shall show the applicable sales tax. These subtotals shall then be shown as a total for labor and material costs. The labor and material cost shall then show the allowed mark-up, and a final total. Subcontractor quotes shall be presented in the same format on the subcontractor's letterhead. Each item totaled on the Contractor's summary sheet shall be separated in the back up documentation by a colored sheet of paper. For change orders that delete any part of the work within the change order and/or contain deductive costs, the back up shall show the original material and labor for the deleted work or costs. If the change order contains both adds and deducts for the same type of work then the material unit and labor unit costs shown on the back up for the deleted work and the added work shall be the same and the net difference shown. Deductive change orders shall show the proper reduction in OH&P and the bond. The Contractor shall also provide HUB utilization information on NC State's Hub Utilization form. Failure by the Contractor to provide the information requested in this paragraph shall result in rejection of the change order by the designer and a request for re-submittal. Delay in the processing of the change order due to lack of proper submittal by the Contractor in accordance with this paragraph, or due to errors in the change order calculations shall not constitute grounds for a time extension or basis for a claim.

2. For all proposed change orders, the procedure will be for the designer to request proposals for the change order work in writing. The Contractor will provide such proposal and supporting data in suitable format and as required in General Condition Article 19 – Changes in the Work, paragraph “c”, “d”, and “e”. The designer shall verify correctness and determine that the Contractor's proposed costs are equitable. After receipt of the Contractor's proposal and if the proposal is correct and it is agreed to by the designer and NC State that the cost is equitable then NC State shall prepare a change order and forward it to the Contractor for his signature. If the change order proposal is incorrect, or the cost has not been agreed upon by the designer and NC State then the designer shall notify the Contractor that the proposal is rejected and the proposal shall be re-submitted. If the proposal is rejected because the cost are deemed not to be equitable then the contracting parties shall negotiate and agree upon the equitable value of the change and the proposal shall be resubmitted with costs determined under General Condition Article 19 – Changes in the Work Paragraph “e”.
3. Once proposed change orders have been reviewed and approved by the Contractor, Designer and NC State, the change order shall be processed for

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signatures electronically through the State Construction Office (SCO) web-based Interscope program. Directions for using Interscope shall be provided at the Pre-construction Conference.

4. If for whatever reason Interscope cannot be used for processing change orders, change orders shall be processed in hard copy format in accordance with General Condition Article 19 – Changes in the Work. The change order shall contain a brief description of the work on the 1st page of the SCO form and again on the second sheet of the form under “DESCRIPTION OF CHANGE”. On the second sheet there shall also be a brief description of the reason for the change along with a cause code listed. Each item totaled on the Contractor’s summary sheet shall be separated in the back up documentation by a colored sheet of paper. After receipt of the change order executed by the Contractor, the designer shall, certify the change order by his signature and forward the change order and all supporting data to NC State for signature. NC State shall execute the change order and forward to the State Construction Office for final approval. The State Construction Office shall review and upon approval execute the change order and keep one copy. The remaining copies are sent to the designer for distribution to NC State (two copies with original signatures) and to the Contractor (two copies). The Contractor shall forward a copy to his Surety. In the case of an emergency or extenuating circumstances, the approval of the changes may be obtained verbally by telephone or field order approved by all parties.
 5. The Contractor shall also provide HUB utilization information on NC State’s Hub Utilization form.
 6. Failure by the Contractor to provide the information requested in this paragraph shall result in rejection of the change order by the designer and a request for re-submittal. Delay in the processing of the change order due to lack of proper submittal by the Contractor in accordance with this paragraph or due to errors in the change order calculations shall not constitute grounds for a time extension or basis for a claim.
- V. A time extension due to Weather - A rain day is defined as any day that rain exceeds one tenth of one inch (0.1"). The Contractor may only be entitled to extension of the contract period for the number of rain days that exceed the normal number of rain days for any given month. For the purpose of determining extent of delay attributable to unusual weather, a determination shall be made by comparing the weather for the contract period with the preceding five (5) year climatic range average during the same time interval based on statistics kept at NC State's Marine, Earth and Atmospheric Sciences department located on NC State's campus and on daily weather logs kept on the jobsite by the Contractor, reflecting the effect of the weather on progress of the work and initialed by the designer's representative. Time extensions for weather delays do not entitle the Contractor to “extended overhead” recovery and are in all other ways non-compensable.

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Notwithstanding the immediately preceding paragraph, not all rain days above the normal number of rain days will warrant a contract time extension. Justification for the request for rain related contract time extensions must also be based on the effect of the rain on critical path work activity in progress during the period of the request and additionally be predicated on the Contractor's diligent prosecution of the work. No additional rain days shall be granted for building projects after the building has been "dried-in" as determined by the designer. The contract time extension request must incorporate work logs kept at the jobsite by the project superintendent showing the effect of the weather on the progress of the critical path work and the critical path schedule, both initialed by the designer's project representative.

Requests for contract time extensions based on rain days must be received by the designer on or before the 20th day of the month immediately following the month in which the rain occurred. The request must include all required documentation. All parties to this contract agree that the Contractor has no right to claim a contract time extension if the request is not received by the designer in strict accordance with the procedure set forth in this paragraph.

For other types of weather delays, the Contractor is granted one (1) day of contract extension for each day NC State is closed due to weather.

W. Final Inspection and Acceptance

1. In addition to all other contract inspection requirements, the following items shall be completed prior to scheduling a final inspection:
 - a) Training of NC State's Facilities Operations personnel shall be conducted with approved Operation and Maintenance Manuals (O&M's) provided at the training sessions.
 - b) Deliver to NC State one copy of all approved shop drawings (submittals) for the project.
 - c) Stairs: prior to final inspection, the Contractor shall submit to the Designer and NC State for review and approval as-built survey drawings of each set of stairs (exterior and interior) constructed as part of this contract. As-built survey drawings shall include dimensions of each riser and each tread and shall bear the seal of a licensed surveyor registered in the State of North Carolina. The Designer shall determine that the stairs are in full compliance with the current State of North Carolina Building Code, and if not in compliance, the Contractor, at his expense, shall make all required corrections, resurvey and resubmit as-builts for re-review and approval by the Designer and NC State.
2. The Contractor shall complete the following list, indicating the date of completion, prior to scheduling a final inspection and recommending acceptance of the project to NCSU. Items 1 and 2 must be completed prior to "substantial

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completion” as defined in Supplementary General Conditions 3.0 Article 23
“Time of completion - the Contractor shall coordinate with NC State the
completion of some items on the list as required:

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Project Acceptance Checklist (also to be used for Beneficial Occupancy when applicable)

Project Name:

Code: **Item:**

Note: All items must be checked off with dates & initialed

accordingly

	Initial & Date
I. Pre-final Inspections	
A. Critical Items Check List:	
1. NCSU Environmental Health Safety Department certification of fume hoods	
2. NCSU Fire Marshall's inspection of life safety systems (FAS, Sprinkler System, Emergency Generator, Fire Pumps etc)	
3. Fire Extinguishers installed or delivered to NC State	
4. Roof & window water tests (when required)	
5. Date to coordinate NCSU Fac Ops Lock Shop to install locks and test in conjunction with Life Safety	
6. State Construction Office electrical inspection(s) complete	
7. Fire alarm inspection and certification by installer and design engineer complete	
8. Fire alarm inspected & approved by NCSU Electronics Shop & Fire Marshall	
9. Elevator inspection by Dept. of Labor, approval to operate the elevator obtained	
10. Demonstration of operation of fire pumps to NCSU Fire Marshall	
11. Operation of emergency and stand by power circuits verified	
12. Operation of emergency generator verified	
13. Dept. of Health water test results and approvals delivered to designer	
14. Dept. of Labor pressure vessel inspections and certificates issued and displayed.	
15. Endorsement of surety for beneficial occupancy (if applicable)	
16. Endorsement of Contractor's insurance company for beneficial occupancy (if applicable)	
17. Approval of SCO for beneficial occupancy (if applicable)	
18. Date for insurance transfers established	
II. Training and instruction of Facility Operations Personnel on Equipment	
A. Record of Instruction Sessions:	
Plumbing	
HVAC/ Controls	
Electrical	
Fire Alarm	
B. NC State O & M Manuals and pressure vessels info delivered to NC State	
III. Pre-Final Inspection	
A. Pre-final Punch list Certified as Complete by the Designer:	
General	
Mechanical	
Plumbing	
Electrical (including fire alarm system)	
IV. Final Inspections with SCO	
A. Date of Final Acceptance Inspection with SCO	
1. Date SCO punch list items complete	

All items complete and verified by the Designer

Signed _____ **Date:** _____

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- X. Request for Payment – In addition to General Conditions Article 31 – Requests for Payments, Contractor payment applications shall have the following information clearly shown on the front page: NC State project number, Code & Item, State Construction Office Project Identification Number. No payment may be made for stored materials that are not stored within the project limits or on property owned by the State of North Carolina. Exception may be considered for material stored in a third-party, bonded warehouse with all appropriate documentation provided to NC State. Designer must verify that material is stored in a bonded warehouse and that the stored material is identified as NC State property. No payment shall be certified/approved by the Designer and forwarded to NC State for payment if not accompanied by the following:
1. A letter from the surety company consenting to the progress payment in the amount requested. The amount of the payment shall be shown on the letter.
 2. A completed sales tax statement and form.
 3. An updated CPM schedule.
 4. MBE Appendix "E" Form with accurate subcontract amounts and amounts paid.
 5. NC State project code, item number, project number and the State Construction Office ID number on the 1st sheet.
 6. Pay applications without the information listed shown shall be considered incomplete and cannot be approved.
 7. "Schedule of values" shall include payment line items for various commissioning activities.

No final payment shall be approved by the Designer and/or forwarded to NC State if not accompanied by the following:

8. Certificate of Compliance signed by the Designer of Record.
9. Certificate of Completion signed by the Designer of Record.
10. Completed Tax Statement and Form.
11. Consent of Surety for Final Payment.
12. Contractor's Affidavit of Payment of Debts and Claims.
13. Contractor's Affidavit for Release of Liens.
14. Contractor's General Guarantee.
15. Contractor's statement of any special or extended warranties.
16. MBE Appendix "E" Form with accurate subcontract amounts and amounts paid.

* NC State shall have 30 days from the time that correct and complete payment requests are received to pay the Contractor.

NC State University Design and Construction Guidelines

Division 01 Contractor Safety Requirements

[Designer shall incorporate this document into the specification in its entirety.]

Safety Measures pertaining to COVID-19 Transmission

North Carolina State University is committed to preventing transmission of COVID-19 in our community. Safety protocols have been implemented throughout the university for faculty, staff, and students to prevent the spread of COVID-19. These protocols were developed based on guidance from the Centers for Disease Control and Prevention, the Occupational Safety and Health Administration, and the State of North Carolina. Contractors shall comply with any NC State, federal, state, or local mandates relative to the pandemic. The most stringent requirement shall be enforced, including those established by any contractor's corporate policy in place.

Face Coverings – Student Health Services and CVM Areas

Face coverings must be worn, tightly covering the mouth and nose, inside all buildings (even those under construction). Until further notice, NC State Student Health Services and the College of Veterinary Medicine (CVM) will require face coverings to be worn by contractors while indoors in any facility until further notice. Minimum expectation is that face coverings must be properly worn at all times while indoors; face coverings may be removed only while eating and/or drinking.

1.0 Purpose

- A. The purpose of this guideline is to define NC State contractor safety requirements. This guideline is intended to be a supplement to the General Conditions of the contract.
- B. The Designer shall incorporate this document into the Project Manual in its entirety.
- C. Contractors and subcontractors are responsible for the safety of their employees and all persons on and around a work site. Contractors are solely responsible for the development and implementation of their safety programs. This document does not relieve the duty and responsibility of contractors, subcontractors, their agents, employees, and other persons performing portions of the work on a project to comply with federal, state, and/or local laws or regulations that relate to work site safety.

2.0 Scope

- A. This document provides contractors with the University's specific requirements that must be incorporated into the contractor's Site-Specific Safety Plan. This document is not designed or intended to replace the contractor's safety program, nor to address every possible safety, environmental, or health hazard associated with the contractor's work. In the event that the contractor's safety program includes a requirement or practice that is more stringent than set forth herein, the more stringent shall be followed. This document does not relieve the contractor of this obligation to: (1) control the means and methods by which its employees, and any subcontractors perform work, and (2) independently ascertain what health and safety practices are necessary for the performance of the work.

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- B. No specific requirements herein shall be construed to limit, replace or supersede applicable provisions of federal, state, or local laws or regulations. [Occupational Safety and Health Administration \(OSHA\) Regulations; Standard Number 29 CFR 1926](#) are the foundation of these Guidelines.
- C. Deliverables
 - 1. Competent Person Designation (see attached form) (4.0/C)
 - 2. Verification of OSHA 30 or OSHA 10 compliance, based on project requirements. (4.0/D/1/b)
 - 3. Contractor Site Specific Safety Plan (SSSP). (4.0/I)
 - 4. Summary of the Daily Safety Inspections documented as part of regular project meeting minutes. (4.0/F/1)
 - 5. Monthly Safety Reports. (4.0/F/2)

3.0 Reference Materials

- A. The following reference materials are required to be available upon request at every job site:
 - 1. OSHA Regulations published by NC Department of Labor (DOL) (Available at: (800) NC-LABOR, <http://www.nclabor.com/pubs.htm>).
 - 2. Safety Data Sheets (SDS) for all chemical products the contractor has brought to the worksite.
 - 3. The written Safety Plan of the Contractor or Subcontractor.
 - 4. Site inspection documentation.
 - 5. Worksite employee training records.
 - 6. Mishap reports and investigations.

4.0 General Responsibilities

- A. The contractor must notify the NC State Project Manager in writing at least 10 days prior to:
 - 1. Utilizing powder-actuated tools
 - 2. Starting operations that will produce excessive odor, dust, noise affecting occupied buildings or work near air intakes
 - 3. Using a combustion engine indoors
 - 4. Using a mobile crane or tower crane (50-day notice is required)
 - 5. Breaking ground for an excavation or trench
 - 6. Using a laser
 - 7. Using any source of radioactive material
 - 8. Working with lead or asbestos containing materials
 - 9. Performing energized electrical work
 - 10. Working on or near active underground utility infrastructure (steam, chilled water, natural gas, water, etc.)
 - 11. Entering electrical distribution assets

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Violation of any safety, security, or environmental requirement may result in the permanent removal of the contractor or their employees from the NC State premises.

B. Construction Management

1. Contractor is responsible for compliance with all federal, state, and local laws, regulations, standards, executive orders, etc. applicable in part or whole pertaining to the scope of work.
2. Contractors are responsible for compliance with all applicable NC State safety practices, procedures, policies, standards, and requirements.
3. Contractors are responsible for providing qualified and competent personnel to perform activities under the scope of work. Contractors must provide documentation of training prior to beginning work on-site.
4. Contractors are responsible for ensuring that subcontractors, their agents, employees, visitors, and other persons performing portions of the work on a project comply with federal, state, and/or local laws or regulations that relate to work site safety.
5. Contractors are responsible for ensuring that subcontractors are informed of and comply with all applicable requirements within the scope of work.

C. Competent Person Designation

1. Contractors shall designate a competent person for activities as specified in OSHA 29 CFR 1926. Such activities include, but are not limited to, the following activities, as applicable to the job:
 - a) general provisions
 - b) ionizing/non-ionizing radiation
 - c) gases, vapors, fumes, mists, dusts
 - d) ventilation
 - e) hazard communication
 - f) lead
 - g) asbestos
 - h) personal protective equipment
 - i) hearing conservation
 - j) respiratory protection
 - k) rigging and material handling equipment
 - l) welding, cutting, brazing
 - m) electrical
 - n) scaffold
 - o) fall protection
 - p) cranes (overhead and mobile)
 - q) motor vehicles and equipment
 - r) excavations
 - s) concrete and masonry
 - t) steel erection
 - u) demolition

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- v) stairways and ladders
- w) toxic and hazardous substances.
- 2. OSHA 29 CFR 1926.32(f) "Competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- D. Contractor Safety Personnel
 - 1. Safety Representative
 - a) For all projects contractors must designate a Safety Representative prior to the start of the project. The Safety Representative may be the Project Superintendent, and as such, must be onsite during any and all construction operations.
 - b) **For projects bid through Capital Project Management, the Safety Representative must have completed, at a minimum, an OSHA 30-hour Construction Safety Course. For projects bid through Construction Services, the safety representative must have completed, at a minimum, an OSHA 10-hour Construction Safety Course.**
 - c) The Safety Representative must actively monitor the jobsite for safety issues on a daily basis. The safety representative may have additional site duties outside the scope of safety; when the safety representative is not on the project site, a competent designee must be assigned to monitor safety on the site.
 - 2. Safety Professional
 - a) When appropriate, the contractor shall provide a full-time safety professional assigned to the project. The duties of the full-time safety professional must be strictly limited to safety-related activities, with no additional job site duties.
 - b) Safety professionals must have one or more of the following credentials: a professional certification (beyond an OSHA 30-hour course), a college or professional degree related to safety and health, or significant previous experience and skills necessary to thoroughly understand the health and safety hazard and controls relevant to the project. The designation and adequacy of qualifications of the full-time safety professional shall be reviewed and accepted by the University prior to commencement of the work.
 - c) Project-specific requirements for a full-time safety professional will be addressed in the contract documents and discussed during the Pre-Bid Meeting.
- E. Daily Pre-Job Meetings.
 - 1. A pre-job meeting (i.e. "Tailgate" or "toolbox" meeting) shall be held at the beginning of each work period (normally in the morning before leaving the yard or work staging area). The pre-job meeting should include a discussion of the scope of work to be completed, associated hazards, and means and methods to mitigate the hazards. The pre-job meeting must be led by the supervisor or other competent person.
- F. Safety Inspections.
 - 1. Daily Inspections: The Contractor shall perform daily job inspections and correct any unsafe conditions or actions. A summary of these inspections will be reviewed as a

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- portion of and captured in the minutes of the weekly Owner, Designer, Contractor job meetings.
2. Monthly Inspections: For projects with a duration of more than one calendar month (4 weeks), the safety inspection must be documented and include, at a minimum, the name of the person performing the inspection, the date, a checklist of items observed, any identified safety concerns, and actions taken to address identified concerns.
 3. University Project Visits: The NC State Project Manager, or other owner representative, may perform unscheduled visits to project sites to address adherence to the Contractor Safety Requirements or Site-Specific Safety Plans. Any safety concerns identified will be reported to the responsible contractor for prompt mitigation.
- G. Mishap Reporting: All mishaps occurring on the project site must be investigated to determine causes and actions must be taken to prevent recurrence. Mishaps resulting in injury requiring medical treatment or damage to NC State property must be reported in writing to the NC State Project Manager as soon as possible but no later than 24 hours from occurrence; the Project Manager shall be notified immediately of mishaps resulting in life-threatening injury.
- H. The Contractor shall address safety concerns at regularly scheduled meetings with subcontractors.
- I. Contractor Site-Specific Safety Plan - The Contractor must develop and implement a Site-Specific Safety Plan (SSSP) The SSSP is a comprehensive safety plan for his or her employees, which covers all aspects of onsite construction operations and activities associated with the contract. This plan must comply with all applicable health and safety regulations and any project-specific requirements. The Safety Plan must be submitted to, reviewed and accepted by NC State prior to beginning any on-site work activities.
1. As applicable to the project, these items must be included in the Safety Plan:
 - a) Scope of Work
 - b) Emergency Procedures
 - c) 24-hour emergency points of contact
 - d) Identification of Designated Competent On-Site Personnel (per OSHA requirements)
 - e) Designated On-Site Safety Personnel
 - f) Safety orientation program
 - g) Site logistics Plan: address public (student, faculty, staff, visitor) safety, traffic plan, equipment and lay-down areas, site security, dust containment, etc.
 - h) Minimum PPE requirements
 - i) Hazard Assessment (for defined project tasks) - include hazard identification and mitigation
 - j) Mishap reporting and investigation procedures
 - k) Safety inspection/audit procedures
 - l) Sub-contractor requirements

5.0 General Requirements

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- A. Asbestos - If asbestos-containing materials are uncovered during construction, NC State must be notified *immediately*. Do *not* attempt to remove the material. Contractors shall comply with provision of the [State Construction Office Asbestos Abatement Guidelines and Policies](#) and the [NC State Asbestos Management Plan](#).
 - 1. If asbestos containing material is present in any building material and is in good condition (i.e. non-friable) and will not be disturbed during construction, the material may be left in place. If asbestos containing material is disturbed during construction activities, then it shall be removed; removal shall be performed by appropriately qualified and accredited personnel and in accordance with federal, state and local regulations.
- B. Compressed Gas Cylinders
 - 1. Compressed gas cylinders shall be properly used, stored, and maintained as per federal, state, and local requirements.
 - 2. Cylinders shall not be stored in a location in which they are subject to mobile equipment traffic (including vehicles) unless adequately protected.
- C. Confined Space Entry
 - 1. Contractors required to enter a confined space at NC State must have and implement a written confined space entry program in accordance with OSHA 1926 Subpart AA Confined Spaces in Construction or OSHA 1910.146 permit required confined spaces, as applicable.
 - 2. Controlling contractors (those with overall responsibility for construction at the work site) must ensure space entry coordination when more than one entity will enter the space.
 - 3. Each contractor must have a competent person that will identify confined spaces associated with the scope of their work. Before entry into a permit required confined space, contractors must obtain the following information from the controlling contractor (when there is no controlling contractor, the contractor will obtain the information from the NC State Project Manager):
 - a) The location of each known permit space associated with the project scope;
 - b) The known hazards or potential hazards that make it a permit space;
 - c) Any precautions needed to be taken based on the known hazards or potential hazards.
 - 4. Each contractor performing work in a permit space must perform a hazard assessment specific to the work to be performed and establish corresponding hazard controls.
 - 5. A competent person from each contractor performing work in a permit space must complete and sign [Appendix F](#) to the [NC State Confined Space Entry Program](#).
- D. Contaminated Soil - If soil or any materials appear to be contaminated, the NC State Project Manager must be notified immediately. The NC State Project Manager will contact NC State EHS for assistance (919) 515-7915.
- E. Electrical Power Lines (Overhead) - The contractor shall have a trained and knowledgeable observer (signal person) within sight of the operator and the overhead lines that will effectively provide guidance and clearance information to the operator as the equipment

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may approach the minimum approach distances. Advising the operator shall be the signal person's one and only task. When conducting any work with a crane, derrick or hoist in the vicinity of any overhead electric power transmission or distribution line, the contractor shall observe all clearance requirements dictated by all applicable OSHA rules, as specifically contained within 29 CFR 1910 - Standards for General Industry, CFR 1926 - Standards for Construction, IEEE C2 - NEC, NFPA 70 - NEC, the NCSBC, ANSI standards and other applicable NC State safety guidelines and requirements. Further, no crane, derrick or hoist operator or contractor shall conduct any operation at any distance closer than 20 feet to any electric power line lower than 200 kV or closer than 35 feet to any electric power transmission line at voltages higher than 200 kV and lower than 250 kV, unless the requirements of OSHA 1926 Sub CC for preventing encroachment/electrocution are strictly followed.

- F. Elevators/Material Hoists
 1. Any persons operating elevators/hoists must be trained to do so. Documentation shall be kept onsite.
 2. No elevator/hoist with a defect shall be used.
 3. Elevator/hoist safety devices shall not be overridden or made inoperable.
- G. Emergency Equipment- The following shall not be moved, blocked, disabled or rendered inaccessible unless authorized by NC State:
 1. Fire equipment
 2. First aid equipment, fire blankets, stretchers, eyewash fountains and safety showers
 3. Fire protection, hydrants, and detection systems
- H. Emergency Medical Treatment - To receive immediate assistance for emergency medical treatment call 911.
- I. Environmental and Chemical Requirements
 1. Contractors must provide NC State with a list of all chemicals to be used on NC State property and maintain a copy on site of the SDS for each chemical prior to being brought on site. Each chemical container must be labeled clearly with the identity of the chemical and any associated hazards in accordance with the OSHA Hazard Communication Standard (1910.1200).
 2. Contractors must follow the safety procedures recommended by the manufacturer or seller of any chemicals, tools, equipment, or other materials. Contractors are to remove all empty containers, excess chemicals and chemical waste from NC State property.
 3. For all chemical incidents, contractors shall call 911 and also notify the NC State Project Manager.
- J. Excavation and Trenches - Before doing any excavation work, the Contractor must locate all utilities by calling the local utility locator service and NC State.
- K. Excavations
 1. Underground Facilities Locate. Contractors shall ensure underground installations and facilities are identified by calling 811 (Call Before You Dig) before performing any excavating activity. Note: excavation includes movement or removal of earth, rock, or other materials in or on the ground by use of manual or mechanized equipment. This is

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required for any project with earth-moving activities before you dig so that underground facilities can be identified and avoided. Detailed instructions and requirements can be found at nc811.org.

2. Competent Person. Trench and excavation work must be performed under the direction of a competent person. Responsibilities include: classifying soil, inspecting protective systems, monitoring water removal and conducting site inspections.
 3. Cave-In Protective Systems. A protective system is required by OSHA-1926 Subpart P for trenches and excavations that are 5 feet or more in-depth OR if the competent person has examined the ground and finds indication of a potential cave-in. Protective systems typically include: sloping/benching, shoring or shielding. In order to determine what protective systems are appropriate, the competent person must first determine the soil type: Stable Rock, Type A, Type B or Type C soil. Type C soil is the least cohesive and therefore, the least stable. No work shall be permitted in excavations where water has accumulated unless the integrity of the excavation has been protected.
 4. Excavations >20 feet in depth or which cannot comply with OSHA requirements require written approval by a Registered Professional Engineer (RPE).
 5. A ladder, stairway, ramp or other means of access must be provided within the excavation, when excavations are >4 feet in depth.
 6. Barricades (stop-logs) shall be provided where vehicles or mobile equipment are used near or adjacent to excavations.
 7. Spoil piles must be placed a minimum of 2 feet from the edge of the excavation.
 8. Air monitoring must be performed if the excavation is >4 feet in depth and there is a potential for a hazardous atmosphere to exist.
- L. Exit Routes
1. Exit routes must be maintained at all times during construction.
 2. Lighting and marking must be adequate and appropriate.
 3. Exit routes must be kept free of explosive or highly flammable furnishings.
 4. Exit routes must be free and unobstructed. No materials or equipment may be placed, either permanently or temporarily, within the exit route. The exit access must not go through a room that can be locked, such as a bathroom, to reach an exit or exit discharge, nor may it lead into a dead-end corridor. Stairs or a ramp must be provided where the exit route is not substantially level. No materials shall be stored in a stairwell.
- M. Explosives: Blasting on university property is prohibited.
- N. Fall Prevention. A fall hazard is any condition on a walking-working surface that exposes an employee to a risk of fall on the same level or to a lower level. Examples of fall hazards include, but are not limited to: floor openings, hoist area, roofs, leading edge, scaffolding, ramps, etc.
1. Preventing or protecting falls from height may be necessary at any height given the circumstances, but is required when an employee is at a height of 6 feet or more above a lower level.
 2. Contractor work generally falls within construction industry applications, where acceptable methods depend on the type of work being performed: unprotected sides or

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edges, roof work, leading edge, etc. In all cases, contractors shall comply with the respective OSHA standards.

3. Contractors shall ensure that every employee required to work at unprotected heights (greater than 6 feet) are trained in fall hazard recognition and prevention.
4. **Guardrail System.** A guardrail system provides the highest level of protection and is always preferred. The system must be capable of supporting 200 lbs. in any direction and still maintain its integrity. The individual heights of the components must conform to the following minimum standards:
 - a) The top rail of the system must be at a height of 42" (+ or - 3");
 - b) the mid rail must be at a height of 21" with a 3" variation possible;
 - c) the toe board must have a minimum vertical height of 3.5".

Note: building code has more stringent requirements for permanent installations.

5. **Personal Fall Protection Systems.** At times, it is necessary to work in areas where guardrails cannot be constructed; in these instances, a personal fall protection system must be used. Personal Fall Protection Systems are systems (including all components) that provide protection from falling or that safely arrest a fall. Examples include travel restraint and personal fall arrest. All components of this system shall meet the applicable design requirements as specified in OSHA 1910, 1926, or ANSI Z359. All components shall be inspected by the wearer prior to each use and at least annually by a competent person. No employee may use a personal fall protection system without proper training and an understanding of proper use and safe application of the system.
 - a) **Travel Restraint System.** A travel restraint system is a combination of an anchorage, anchorage connector, lanyard (or other means of connection) and body support that the wearer uses to eliminate the possibility of going over the edge of a walking-working surface. Anchorages for travel restraint systems shall have a strength capable of sustaining static loads of at least 1,000 lbs. (per person) or two times the foreseeable forces for certified anchorages. Anchorage connectors, lanyards (or other means of connection) and body support devices shall be used in accordance with the manufacturer's requirements. The system shall be installed so that a fall cannot occur; therefore, a rescue plan is not required.
 - b) **Personal Fall Arrest System.** A personal fall arrest system is a system used to safely arrest a user in a fall from a walking-working surface. It includes an anchorage, anchorage connector and a full body harness. The means of connection may include a lanyard, deceleration device, lifeline or a suitable combination of these. Equipment must be worn and used in accordance with the manufacturer's requirements. Anchorages for personal fall arrest systems shall have a strength capable of sustaining static loads of at least 5,000 lbs. (per person) or two times the maximum arresting force for certified anchorages. The system shall be installed so that should a fall occur, the wearer will not contact the lower level or any other obstruction. Since there is a potential for a fall to occur, a rescue plan written by a qualified person is required.

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- c) **Warning Line System.** A warning line may be used for construction roofing work when closer to the fall hazard than 15ft, but no closer than 6ft and in conjunction with one of the following: a guardrail system, a safety net system, a personal fall protection system, or a safety monitoring system. A warning line system shall conform to regulatory requirements and enclose all authorized employees conducting work protected by the Warning Line System. Refer to OSHA 1926.502(f).
- O. Fire Protection and Prevention
 1. The contractor shall be responsible for the development and maintenance of an effective fire protection and prevention program at the job site throughout all phases of the construction. Contractors shall perform inspections on fire extinguishers monthly. Contractors shall immediately replace fire extinguishers that do not pass inspection.
 2. Fire cutoffs shall be retained in buildings undergoing alterations or demolition until operations necessitate their removal.
 3. If work requires the disabling of Fire Protection Devices, then the Contractor must request a Fire Alarm Disconnect; through the appropriate NC State process; beginning with the Project Manager. No alarm shall be disabled at any time by the Contractor.
- P. Hand and Power Tools
 1. All hand and power tools and similar equipment, whether furnished by the employer or the employee, shall be maintained in a safe condition. Any tool found not in proper working order, or that develops a defect during use, shall be immediately removed from service and not used until properly repaired.
 2. All tools shall be used, operated and maintained in accordance with OSHA and manufacturer requirements.
- Q. Hot Work Permits - A Hot Work Permit is required when any indoor or outdoor work will involve hot work, defined as operations including cutting, welding, thermite welding, brazing, soldering, grinding, thermal spraying, thawing pipe, installation of torch-applied roof systems or other similar activities. Requirements for Contractors performing this work are contained in the NC State Hot Work Permit Program that is a part of the specifications package and can also be found at [Hot Work Permit Form](#).
- R. Housekeeping
 1. The Contractor must maintain a clean and orderly project job site. The Contractor shall maintain NC State's pathways free of rocks, mud, and other miscellaneous construction debris. The Contractor shall prevent the accumulation of dirt, dust, and/or other debris on NC State's roadways. The Contractor shall clean the travel ways on a daily basis. (Refer to project specifications for requirements.)
 2. Waste material and debris must be removed from the work and access areas at least once a day. Waste material and debris should not be thrown from one level to another but should be carried down, lowered in containers or deposited in a disposal chute.
 3. Materials must be neatly piled, stacked or otherwise stored to prevent tipping or collapsing. Materials must be carefully stacked and located so they do not block aisles,

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- doors, fire extinguishers, safety showers and eyewash stations, fixed ladders or stairways.
4. Material to be lifted by crane or other hoisting devices must not be stored under overhead power lines.
 5. No materials may be stored on penthouses, roofs, or other areas until a specific area is assigned by NC State for a specific project.
 6. Adverse Weather: If NC State becomes aware of an adverse weather event, the NC State Project Manager shall notify the construction superintendent, and the contractor shall perform a job site review to ensure any debris or construction materials are secured and protected from the elements.
- S. Illumination - Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lit to not less than the minimum illumination intensities required by OSHA.
- T. Ladders - All ladders must meet OSHA requirements.
- U. Lasers
1. Lasers must comply with the OSHA Construction Industry Standards.
 2. Lasers must be low power (<5mw) devices with visible beams. Lasers to be used must bear a label indicating this maximum power output. Lasers that do not bear this label shall not be used.
 3. "Laser in use" signs shall be posted according to OSHA requirements.
 4. Lasers must be used in a manner that will not risk exposure to others.
- V. Lead
1. Lead may be found in certain painted surfaces. A check for lead presence should be conducted prior to certain activities such as grinding, sanding, or burning over painted surfaces. If lead containing paint is disturbed or a material is questionable the NC State Project Manager must be notified *immediately*. Do *not* attempt to remove the material.
 2. Hot Work over lead painted surfaces is generally not permitted.
- W. Lock Out/Tag Out
1. All contractors that work on energized equipment with any hazardous energy source are required to have a hazardous energy control (i.e. lockout tagout) program. The program shall specify policy and procedures for deenergizing, verifying deenergized, and secure the source potential using energy isolating devices and applying locks/tags or implement other forms of hazardous energy control as specified in OSHA standards. Types of potential energy sources include, but are not limited to:
 - a) Electrical (refer to section of these requirements titled "Electrical") Pneumatic
 - b) Hydraulic,
 - c) Thermal
 - d) Kinetic (motion)
 - e) Hazardous gas, liquid, air
 - f) Radiation
 - g) Lasers

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2. When multiple contractors are performing work on the same project, hazardous energy control procedures shall be coordinated by the controlling entity which includes establishing device standardization.
 3. Contractors shall ensure site personnel are trained on the hazardous energy control program.
 4. Central [Utility Plant \(CUP\) - Lockout Tagout Procedure](#).
 - a) Contractors with the need to perform LOTO operations within the operating CUP shall be trained in accordance with the procedure and comply with applicable sections of the procedure. The contractor is responsible for providing this training; a copy of this procedure will be provided to the contractor.
 - b) Contractor management shall ensure that authorized personnel are assigned to perform work in which they are qualified.
 - c) Contractor management shall comply with applicable sections of the procedure.
- X. Mobile Cranes, Tower Cranes, etc. (Reference OSHA 1926 Subpart CC).
1. Prior to the set up or operation of any crane on university property, the NC State Project Manager (or other point of contact) shall be notified; notification must be made with as much lead time as possible, but no fewer than fifty (50) working days
 2. Cranes shall be set up and operated in compliance with the manufacturer and applicable OSHA requirements.
 3. Contractors are responsible for ensuring ground conditions are capable of supporting the equipment and load, which will include performing underground facilities/utilities location (i.e. 811 call) as well as factual confirmation of necessary compaction capacities. This confirmation is to be by third party inspection services, at the expense of the contractor.
 4. No lifts may occur over occupied spaces unless a registered structural engineer evaluates and certifies that the building can withstand the impact of load being dropped on the building as a worst-case scenario. If it is determined that the building cannot withstand the impact without compromising the structure, areas of the building within the load fall zone must be evacuated during the duration of the lift. This evacuation process must be a part of the lift plan and managed by the contractor.
 5. The crane contractor shall provide equipment documentation, including the annual inspection and last monthly inspection. Documentation must be signed.
 6. Crane operators shall be certified by an Accredited Crane Operator Certification Agency for the type of equipment operated. Examples of such agencies, include, but are not limited to:
 - a) National Commission for the Certification of Crane Operators (NCCCO)
 - b) National Center for Construction Education and Research (NCCER)
 - c) Operating Engineers Certification Program (OECF)
 - d) Electrical Industry Certifications Association (EICA)

Additionally, the crane operator's employer must attest that the operator was evaluated to verify the operator demonstrates skills and knowledge to safely

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operate the equipment as well as the ability to recognize and avert risk, as required under 29CFR1926.1427(f).

7. All rigging personnel and signal persons shall be qualified in accordance with OSHA 1926 Subpart CC.
8. Crane Lift Plan. A lift plan is required for any lift in a location not under the exclusive control of the contractor, including lifts affecting NC State property, structures, employees, students, or visitors. Each lift plan must be developed by a qualified person and include at least the following:
 - a) The identity of the controlling entity, meaning the employer with the overall responsibility for construction operations associated with the crane lift.
 - b) Identify a lift director (i.e. primary signal person) and method of communication (hand signals, radio, etc.).
 - c) Contractors conducting crane operations are required to obtain required FAA permits according to 14CFR Part 77; to be submitted with the lift plan.
 - d) Equipment positioning locations, including load staging and movement and paths to and from the working position
 - e) Equipment specifications including load and reach capacities
 - f) Current qualifications, certifications, and licenses of operators and riggers
 - g) For lifts involving more than one crane, the lift plan shall encompass all cranes.
 - h) Fall Zone: The contractor shall identify the Fall Zone. The Fall Zone is the area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall. Spaces within the Fall Zone (including buildings, foot traffic, vehicle traffic, etc.) shall be barricaded to control access. The Fall Zone shall be cleared of personnel not participating in the lift.
 - i) Wind limitations
 - j) Ground and subsurface stability at crane and load placement locations. The contractor must ensure a qualified person evaluates the crane set-up location to ensure ground conditions are sufficient. (See X., 3. above)
 - k) Other conditions or factors that may affect the safety of the lift
 - l) A pre-lift meeting must be completed immediately before the lift and shall include all personnel involved with the lift and a thorough review of the elements and specifics of the lift plan and personnel assignments.
 - m) Specify distance to closest energized lines and applicable minimum approach distance of any lift component.
 - n) Where items positioned by a crane lift are rigged at heights above easy reach height, the lift plan shall include safe attachment and de-attachment procedures and the control of exposure to fall hazards.
 - o) The contractor must provide documentation of annual and monthly inspections for the previous 3 months. 1926.1412(f) & .1412(e)

Y. Electrical

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1. Electrical Contractor shall ensure that their personnel using electrically powered equipment are trained to recognize electrical hazards, inspect and maintain electrically powered equipment, and on safe work procedures to prevent exposure to electric shock.
 2. Premises Electrical Equipment. All electrical installations must comply with the National Electrical Code® (NEC®). Work associated with electrical equipment installed in accordance with the NEC® will be conducted in accordance with NFPA 70E® Standard for Electrical Safety in the Workplace. NC State's goal is to minimize exposure to shock and arc flash hazards during the installation, repair, maintenance, and operation of electrical equipment, components, and systems.
 - a) Electrical power sources shall be deenergized, verified, and locked out prior to working on electrical equipment except when de-energization creates a greater hazard and a properly executed Energized Electrical Work Permit (EWP) has been completed.
 - b) Contractors performing electrical work must have their own energized electrical work program that includes a permit process.
 3. Power Generation & Distribution: Work by Qualified Persons and Unqualified Persons working on or near power generation or distribution equipment is addressed in OSHA 29CFR1910.269. It includes work on or directly associated with installations used for the generation, control, transformation, transmission, and distribution of electricity. Any work involving the NC State distribution system shall be coordinated by the NC State Project Manager (or other university contact person) in collaboration with the Facilities Division Power Systems group.
 - a) Work involving the NC State electrical distribution system shall only be performed after authorization by the Facilities Division Power Systems group in accordance with the Power Systems Switching Procedure.
 - b) System Check In/Out: Prior to entering any primary enclosure (substation, transformer, manhole, switch, switching station, etc.) of the NC State Power System the NC State Project Manager or other designated person shall send a text or email to group-powersystementry@ncsu.edu with the work location and brief description of the tasks to be performed (photos are welcomed). When exiting the enclosure, check out with NC State Power Systems using the same method. This is only for unescorted access. For example, if you're with a member of the Power Systems team there's no need to check-in/out, but if that team member has to leave your work site, you're expected to check-in and check-out.
 4. Contractor will follow all requirements as noted in NFPA 70E.
- Z. Mobile Elevating Work Platforms (MEWPs)
1. General Requirements.
 - a) MEWPs shall be operated in accordance with the manufacturer's requirements and specifications.
 - b) Employees must always stand firmly on the floor of the MEWP and must not sit or climb on the edge of guardrails, or use planks, ladders or other devices for a work

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- position. The guardrail system of the platform must not be used to support materials, other work platforms, or employees.
- c) A personal fall arrest/restraint system shall be used in accordance with the manufacturer's requirements. A scissor lift with approved guardrails may be used without a personal fall arrest system when specified by the manufacturer, however, if there are designated anchor points, the use of a fall arrest/restraint system is required.
 - d) The MEWP must be used only in accordance with the manufacturer's operating instructions and safety rules.
 - e) The designed rated capacity for a given angle of elevation must not be exceeded.
 - f) At least 10 ft distance must be maintained away from overhead power lines with a nominal voltage of 50kV or less; 20 ft for power lines over 50kV (or if voltage is unknown). Note: qualified workers using appropriately insulated MEWPs may approach closer than 10 ft when following provisions specified in OSHA 1910.268, 1910.269, and 1926 Subpart V, as applicable.
 - g) The manufacturer's rated load capacity must not be exceeded. The load and its distribution on the platform must be in accordance with the manufacturer's specifications. The rated load capacity must not be exceeded when loads are transferred to the platform at elevated heights. Only employees, their tools, and necessary materials must be on or in the platform.
 - h) A trained spotter with no other job duties is required when a MEWP is driven; the spotter will assess conditions that could pose a hazard to the operation (for example, drop-offs, holes, slopes, inadequate surface and support, obstructions, pedestrians, vehicles, debris, electric lines, etc.) and stop operations and alert the operator. The operator shall halt operations until hazards are adequately controlled.
2. Training
- a) Only personnel who have received training to operate the specific type(s) of MEWPs are authorized to operate them on NC State property.
 - b) Training must include inspection, application, and operation of MEWPs (including recognition and avoiding hazards associated with their operation). Operators are only authorized to use MEWPs of the specific model for which they are trained and evaluated.
 - c) Training must be provided by a person who has knowledge regarding the laws, regulations, safe use practices, manufacturer's requirements, and recognition and avoidance of hazards, and is familiar with the specific type(s) of MEWPs. Note: Personnel may not operate rented equipment unless qualified to operate the specific equipment; the rental provider or other authorized evaluator must provide familiarization training to satisfy this requirement.
3. Inspection, Maintenance, and Testing
- a) Each MEWP must be inspected, maintained, repaired, and kept in proper working condition in accordance with the manufacturer's operating or maintenance and

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repair manual or manuals. Maintenance inspections shall be completed at intervals no less frequent than annual.

- b) Before use, visual equipment inspections and a functional check must be performed before each shift in accordance with the manufacturer's operating manual. Any MEWP found not to be in a safe operating condition must be removed from service until repaired. All repairs must be made by an authorized person in accordance with the manufacturer's operating or maintenance and repair manual or manuals.
- c) Before and during use, visual worksite inspections must be performed and include workplace risk assessment. The workplace risk assessment includes identifying and evaluating hazards (for example, drop-offs, holes, slopes, inadequate surface and support, obstructions, pedestrians, vehicles, debris, electric lines, etc.) and establishing effective control measures. Uncontrolled hazardous situations must be corrected prior to initial or continued use of the MEWP.

AA. Noise/Vibration

- 1. Noise producing equipment, such as power drills, jackhammers, welders, etc., can create sound levels of 80dB(A) or greater in and around a construction area. Notify the NC State Project Manager in advance to determine the appropriate times to operate high noise/vibration equipment for that project's location.
- 2. Appropriate personal protective equipment shall be used when working around high noise/vibration equipment.

BB. Overhead Work

- 1. Work must not be performed above other personnel, including other contractor employees. Affected areas must be roped off or barricaded and marked to prohibit traffic.
- 2. Contractors must not climb on the heating and air-conditioning ductwork, plumbing steam piping, sprinkler piping, electrical cable trays, fixtures, or furniture or use as work platforms.
- 3. Contractors are expected to comply with OSHA fall protection requirements.

CC. Paints and Solvents - Contractors must provide the following safeguards:

- 1. Adequate ventilation must be maintained at all times when paints or solvents are being used. Refer to NC State Odor Prevention and Dust Control in Occupied Buildings for additional information.
- 2. Contractor personnel must use proper respiratory protection and protective clothing when toxicity of the material requires such protection.
- 3. Flammable solvents and materials must be used with extreme caution when possible sources of ignition exist.
- 4. Flammable paints and solvents must be stored in an approved flammable liquid storage cabinet when storage is required inside buildings. Acids and flammables must never be stored together. If an approved flammable liquid storage cabinet is not available, flammable paints and solvents must be removed from the building.
- 5. Flammable liquids must be dispensed in a safety can with a flash screen bearing a Factory Mutual or Underwriters Laboratory (UL) approval.

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- DD. Personal Protective Clothing and Equipment - Contractor shall determine this minimum level of protective equipment to be worn on the jobsite (example: hard hat, eye protection, safety vest, gloves and safety shoes); NC State expects contractors to conform to industry accepted minimum PPE standards, for example, hard hats, safety glasses, and protective toe footwear. Any additional safety equipment required by a specific activity shall also be worn and shall meet or exceed OSHA standards. (Refer to NC State Community Standards for specific COVID-19 related PPE).
- EE. Powder-Actuated Tools
1. Powder-actuated tools are not to be used on NC State property unless specific approval is obtained from NC State prior to usage.
 2. If approved, powder-actuated tools must be used in accordance with OSHA and manufacturer regulations.
- FF. Power Vehicle Equipment
1. Only trained operators are allowed to use power vehicles on NC State property. Contractor management will be expected to provide proof of training if requested.
 2. Generally, LP gas powered trucks are not to be used inside NC State buildings. Prior approval from NC State is required.
 3. The design of the LP gas fueled industrial truck for use within NC State buildings must comply with the following:
 - a) LP gas fueled industrial trucks must comply with NFPA 505-1982.
 - b) If trucks are in continuous use in a populated area, they must be equipped with a catalytic converter.
 - c) LP gas containers must not exceed the nominal 45 pounds LP gas.
 4. The following conditions and requirements will govern the use of LP gas fueled vehicles inside the confines of NC State buildings and structures:
 - a) LP gas fueled trucks must be removed from the building and parked at the end of each workday and not left unattended while in use. When the job requiring the truck is complete, the truck must be removed from the job site.
 - b) Trucks and tanks must not be refueled inside buildings.
 - c) All areas where LP gas fueled trucks are used must be well ventilated.
 5. All LP cylinders must be stored outside and secured by a chain in an upright position.
- GG. Roof Safety
1. The contractor shall request authorization from NC State prior to accessing a roof.
 2. During all rooftop operations, the contractor must provide fall protection measures in accordance with OSHA.
 3. A Hot Work Permit and at least two appropriate fire extinguishers of the correct ABC type are required when performing hot work on roofs. Other persons acting as a Fire Watch shall be in place on the roof and on the floor(s) directly below operation.
- HH. Sanitation
1. Drinking Water - An adequate supply of water, meeting the U.S. Public Health Service Drinking Water Standards, shall be provided.
 2. Washing Facilities

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- a) The contractor shall provide adequate washing facilities for employees engaged in the application of paints, coating, herbicides, or insecticides, or in other operations where contaminants may be harmful to the employees. Such facilities shall be in near proximity to the worksite and shall be so equipped as to enable employees to remove such substances. (Refer to NC State Community Standards for specific COVID-19 related washing requirements).
 - b) Hand soap or similar cleansing agents shall be provided.
 - c) Individual hand towels, cloth or paper, warm air blowers or clean individual sections of continuous cloth toweling, shall be provided.
 3. Toilet facilities shall be provided for employees according to the OSHA requirements.
- II. Scaffolding
1. Contractor shall erect, use and dismantle scaffolding in accordance with OSHA and manufacturer regulations.
 2. Competent Person. Scaffolds must be erected and dismantled under the direction of a competent person. Responsibilities include, but are not limited to:
 - a) supervise and direct scaffold erection, moving, dismantling, or alteration.
 - b) determine the feasibility and safety of providing fall protection for employees erecting or dismantling supported scaffolds. Employers are required to provide fall protection for employees erecting or dismantling supported scaffolds where the installation and use of such protection is feasible and does not create a greater hazard.
 - c) inspect scaffold and scaffold components for visible defects before each work shift and after any occurrence which could affect a scaffolds structural integrity and ensure identified deficiencies are corrected,
 - d) determine if it is safe for employees to work on scaffolds during storms or high winds.
 3. Access. When scaffold platforms are more than 2 feet (0.6 m) above or below a point of access, portable ladders, hook-on ladders, attachable ladders, stair towers (scaffold stairways/towers), stairway-type ladders (such as ladder stands), ramps, walkways, integral prefabricated scaffold access, or direct access from another scaffold, structure, personnel hoist, or similar surface shall be used. Crossbraces shall not be used as a means of access.
 4. Fall Protection. Each employee on a scaffold more than 10 feet (3.1 m) above a lower level shall be protected from falling to that lower level; each employee on a suspended scaffold shall be protected by a personal fall arrest system attached to an independent anchorage.
 5. Falling Object Protection. Where potential for tools, materials, or other equipment could fall from a scaffold, the area below must be barricaded, and personnel not permitted to enter the area OR effective means shall be implemented to prevent objects from falling.
- JJ. Signs, Tags, and Barricades (references 1926 Sub G and ANSI Z535)
1. Signs and Tags: Each sign and tag must include a signal word, symbol, and text.

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- a) Signal words:
 - (1) DANGER = the hazard will most likely result in serious injury or death;
 - (2) WARNING = the hazard could possibly result in serious injury or death;
 - (3) CAUTION = the hazard would not likely result in serious injury or death;
 - (4) NOTICE = indicates important information, but not directly hazard-related.
 - b) Symbols or graphics are used to bridge language barriers and draw attention to the message.
 - c) Text is used to convey the safety message in a clear, concise manner.
2. Barricades. Barricades must be installed for situations where a physical obstruction is necessary to deter the passage of people, vehicles, or equipment. When used, barricades must be installed at all points of access.
- a) Barricades associated with traffic control in a public roadway must comply with the Federal Manual of Uniform Traffic Control Devices and the North Carolina Supplement. Coordinate with the NC State Transportation Office.
 - b) Barricades may take many forms on construction sites, but when used, they must clearly indicate the intent of the barricade. All barricades are required to include a sign that includes the name of the person responsible for the barricaded area, method for contacting the responsible person (ex. phone number), and clear and concise text describing the purpose of the barricade.
 - (1) CAUTION Tape Barricades should be used when the hazardous condition is not likely to cause serious physical harm but could result in injury. Standard CAUTION Tape must be used, which includes yellow tape with the word “CAUTION” in black letters. Personnel may enter the barricaded area only when implementing precautions to address the identified hazard.
 - (2) DANGER Tape Barricades are used when a serious or imminent danger may exist. Standard DANGER Tape must be used, which includes red tape with the word “DANGER” in black letters. Only personnel specifically authorized by the person responsible for the barricaded area may enter the barricaded area.
- KK. Silica (Respirable Crystalline Silica) – The following requirements apply to all operations involving exposure to respirable crystalline silica. Examples of such operations include: cutting, grinding, drilling, or crushing brick, block, concrete, stone, rock, mortar, and other materials that contain crystalline silica.
1. Contractors shall comply with OSHA standard 29 CFR 1926.1153 including taking all necessary steps to comply with the established exposure limits.
 2. Contractors must have a written Exposure Control Plan specific to their operations in accordance with 29 CFR 1926.1153 that includes specific detail for controlling exposure to NC State personnel and the public. A copy of this plan shall be made available to NC State EHS and/or the university Project Manager upon request.
 3. Tasks performed indoors or in an enclosed area, shall have effective exhaust ventilation to minimize the accumulation of visible airborne dust. In situations where ventilation is exhausted in an area with potential to expose people to dust must incorporate effective

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HEPA filtration; such areas include but are not limited to, inside a building or outside where people may be present.

4. When a building ventilation system services an area where work with the potential for generating respirable crystalline silica exists, the building air returns shall be blanked or closed while such work is in progress. Contractors must coordinate this with the university project manager.
5. Contractors must establish a “Temporary Restricted Area” for tasks that require the use of respiratory protection in accordance with 29 CFR 1926.1153.
 - a) *Temporary Restricted Area* means an area demarcated by the employer where an employee is required to wear respiratory protection.
 - b) *Temporary Restricted Areas* must be designated with signs, barriers, or other effective means that will ensure unauthorized persons do not enter.

If such work is performed in *occupied* buildings, dust barriers shall be installed as necessary to isolate the restricted area. Refer to [NC State Odor Prevention and Dust Control in Occupied Buildings](#) for additional information.

LL. Smoking and Open Flames

1. Smoking is not allowed in any NC State buildings, including roofs, penthouses, electrical/mechanical rooms and basements.
2. The use of open flames is strictly prohibited in areas where flammable liquids, gases, or highly combustible materials are stored, handled or processed.
3. The use of open flames, where allowed, requires a Hot Work Permit.

MM. Tarpaulins - When tarpaulins are required for the deflection of hot slag, dust, paint drippings, etc., or as a security barrier, they must be flame resistant and in good condition, free of holes and worn edges.

NN. Tar Pots (tar kettles) - Tar Pots are not allowed on roofs. The contractor must notify the NC State Project Manager prior to using tar pots and obtain a Hot Work permit.

OO. Temporary Heating - When heaters are used in confined spaces, special care shall be taken to provide sufficient ventilation in order to ensure proper combustion, maintain the health and safety of workmen, and limit temperature rise in the area.

PP. Temporary Lighting - Contractor shall submit a lighting plan for night work, underground work, and any other worksites without adequate lighting.

QQ. Temporary Traffic Control

1. All traffic control shall be approved by NC State and meet the Institute for Transportation Research and Education (ITRE) Work Zone Safety Guidelines for Construction, Maintenance and Utility Operations. Should this be referencing the federal [Manual on Uniform Traffic Control Devices](#) and the [North Carolina Supplement to the Manual on Uniform Traffic Control Devices](#)?
2. The contractor shall provide warning signs, barriers, barricades, etc., in accordance with the construction plans and specifications or whenever such protection is needed.
3. Where signs and barricades do not provide adequate protection, particularly along a road, walkway, or main aisle, flagmen shall be used.

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4. Review with the crew, each person's responsibility regarding the traffic control set-up (e.g. sign installation, lane closure setup, etc.).
 5. Review traffic control devices to be used at the site. Assure that traffic control set-up is properly installed. Installer shall document what traffic control set-up was used (including the sign types and sign locations) and how it was installed.
- RR. Vehicle Operation
1. All equipment shall have operational backup alarms. Equipment shall not be utilized until such device is functioning properly.
 2. All vehicles shall be operated in accordance with OSHA and manufacturer regulations.
- SS. Vertical Lifts - All contractors' platforms or vertical lifts must meet OSHA and manufacturer requirements.

SECTION 02 41 13 – SELECTIVE SITE REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section covers the labor and materials necessary for the Work associated with the demolition of existing concrete sidewalks, asphalt paving, and curb and gutter, etc. on the Drawings and specified herein while maintaining continuous operation of the Owner's facilities.
2. The information contained on Drawings showing demolition is based on the available record drawings and information from previous construction projects within the project area. The supplementary information and reference drawings are provided solely for the convenience of the Contractor. Neither the Engineer nor the Owner assumes any responsibility for the accuracy or completeness of these drawings or for the Contractor's interpretation of this supplementary information. The Contractor shall perform all demolition required regardless of type or amount. The Contractor shall inspect the facilities to be demolished as specified in Specifications, to satisfy itself as to the nature and location of the Work. Differences between the Contract Documents and the actual facilities shall not constitute grounds for time extension or contract modifications.
3. Any utility to be relocated in order to facilitate construction should first be coordinated with the Owner and/or owning utility company before the utility is to be interrupted.

1.2 GENERAL

- A. Some obstructions may not be shown. This Contract shall include, as incidental to the Work, removal and replacement of obstructions such as water lines, electric lines, and similar items deemed by the Engineer to be required to meet the design intent shown in these Contract Documents, even though not shown or specifically mentioned.

1.3 DEFINITIONS

- A. Remove: Demolish complete as specified herein including offsite disposal except for those specific portions of removed items specified to be salvaged.
- B. Salvage: Detach and turn over to Owner removed portions of the Work in good working condition or credit the owner the price of the material or item.
- C. Standard Specifications: When referenced in this section, shall mean North Carolina Department of Transportation Standard Specifications For Roads And Structures (Latest Revision). Parts of these Standard Specifications that are specifically referenced shall become part of this section as though stated herein in full. In case of a discrepancy between the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the Division 01 Section "Submittal Procedures". In addition, the following specific information shall apply:
1. The Contractor shall submit to the Engineer for approval, schedules of demolition, including:

- a. Detailed methods and phasing of demolition to be used within the project area including any interruption of existing utility services or access.
 - b. Copies of authorization, and permits, including any excavation permits, to remove the existing utility infrastructure as indicated on the Drawings.
 - c. Inventory of items to be removed and salvaged.
 - d. Pre-demolition photographs showing the existing conditions of adjoining construction and site improvements that might be misconstrued as damage cause by demolition operations.
 - e. Temporary protection measures
2. The Contractor shall make all alterations in the schedule or methods required by the Engineer at the Contractor's sole expense.
 3. No demolition activities shall commence until schedules for demolition have been approved by the Engineer for the affected areas or activities.

1.6 COORDINATION

- A. Prior to beginning demolition work, clearly field-identify all items that are scheduled to be demolished and salvaged.
- B. Conduct a walk-through with the Owner to:
 1. Verify and agree to the items identified for demolition and salvage.
 2. Identify and resolve problems with the existing utility infrastructure that will be a result of the demolition Work.
- C. Do not interrupt any 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 Owner's Representative no fewer than (72) hours in advance of proposed interruption of service.
 2. Do not proceed with interruption of service without Owner's Representative's written permission.

PART 2 - PRODUCTS - Not applicable to this Section

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall set up construction facilities in a neat and orderly manner in accordance with Specifications. Contractor shall accomplish all Work in accordance with the applicable portions of these Specifications and as approved. All operations shall be confined to the Work area.

3.2 PERFORMANCE REQUIREMENTS

- A. All Work shall be performed in conformance with local, State, and federal rules and regulations pertaining to safety and as specified elsewhere in these Specifications.
- B. Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Comply with ANSI A10.6 and NFPA 241.
- D. Contractor shall obtain all necessary local, State, and federal permits (at no additional cost to the Owner) required for the demolition of the elements on site and complete all Work in conformance with local, State, and federal rules. In addition, contractor shall perform (at no

additional cost to the Owner), any required inspections for lead, asbestos, or other hazardous materials prior to demolition and / or as part of obtaining any required demolition permits. The costs for disposing of these materials (if found) shall be part of the base bid.

3.3 DISPOSAL AND SALVAGE OF MATERIAL

- A. Contractor shall remove and properly dispose of all rubble and material from the Site unless otherwise specified or shown on the Drawings. This shall include, but not be limited to, the following: concrete rubble, underdrain piping, storm drainage piping, unsuitable backfill material, fences, brush, wood, and other debris. Contractor shall accomplish disposal offsite in accordance with local, State, and federal laws.

3.4 DEMOLITION ACTIVITIES AND PROTECTION

- A. The Contractor shall be responsible for having all appropriate services located and turned off before demolition is started. The Contractor shall excavate all utility lines to be demolished and shall provide a permanent leak-proof closure for all abandoned water, gas lines, and electrical conduits. Closures shall be made with caps or plugs specifically designed for the applicable piping system.
- B. Where abandoned utility lines are exposed by demolition excavation, they shall be removed. Likewise, all manholes shall be removed.
- C. Pipelines shall be sealed with plugs or caps of the same material as the line, with thrust restraint where applicable. Where plugs or caps are not available, abandoned lines shall be plugged with concrete to prevent groundwater infiltrating the abandoned lines. Work to be in accordance with Standard Specifications, see Construction Drawings for detail.
- D. Existing structures, boxes, pipes, and other items are to be removed, altered, re-located, salvaged, and / or disposed of as indicated on the Drawings or designated by the Engineer. All portions of these items that interfere with Work shall be removed and properly disposed.
- E. Under no circumstances is there to be discharge of any sewage into storm waters.
- F. Existing pavement, curb, walks, and associated items shall be removed and disposed of as indicated on the Drawings or designated by the Engineer. When partially removing pavement or curb, Contractor shall neatly saw cut at right angle to surface. All portions of these items that interfere with Work shall be removed and properly disposed.
- G. All portions of items designated to be removed shall be removed in the entirety and any resulting void shall be filled with compacted material, in accordance with Standard Specifications. The ends of abandoned pipes that are designated to be left in place shall be plugged, capped, or filled with concrete to provide a watertight seal as specified hereinbefore.
- H. The Contractor shall perform all Work in a manner that will not damage parts of the existing infrastructure not intended to be removed. If, in the opinion of the Engineer, the methods of removal, demolition, or cutting used may endanger or damage parts of the infrastructure or affect the satisfactory operation of the remaining infrastructure, the Contractor shall promptly change the method when notified by the Engineer. The Contractor shall examine the existing infrastructure and make a determination of required demolition and other conditions to be encountered in order to accomplish the Work. No blasting will be permitted for demolition activities.
- I. Repair and replacement of existing elements required due to Contractor activities shall be made at the Contractor's sole expense.

3.5 TEMPORARY PROTECTION MEASURES

- A. The Contractor shall perform all Work to prevent damage to all existing facilities and make all provisions necessary to protect the Owner's facilities from damage due the activities of the Contractor, including but not limited to, protection from dust, debris, water, humidity, and fumes.

3.6 SHUTDOWN OF EXISTING OPERATIONS AND UTILITIES

- A. Existing utilities including, but not limited to, water, gas, telecom, and other subsurface utilities, are required to remain in services during construction and modification of the new and existing infrastructure.
- B. All pedestrian, vehicular, and mobile equipment access shall be maintained during construction.
- C. Existing site lighting and security shall be maintained at equal or better conditions during construction.

END OF SECTION 02 41 13

SECTION 02 41 16 - STRUCTURE DEMOLITION

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. Demolition and removal of buildings and site improvements.
2. Removing below-grade construction.
3. Disconnecting, capping or sealing, and abandoning in-place site utilities.
4. Salvaging items for reuse by Owner.

- B. Related Sections include the following:

1. Division 01 Section "Summary" for use of the premises and phasing requirements.
2. Division 01 Section "Photographic Documentation" for preconstruction photographs taken before building demolition.
3. Division 01 Section "Temporary Facilities and Controls" for temporary construction, protection facilities, and environmental-protection measures for building demolition operations.
4. Division 01 Section "Execution" for cutting and patching procedures.
5. Division 01 Section "Temporary Facilities and Controls" for disposal of non-hazardous demolition wastes.
6. Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of non-hazardous demolition wastes and for removal and storage of refrigerant.
7. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings, structures, and site improvements.
8. Division 22 Sections for demolishing or relocating site plumbing items.
9. Division 26 Sections for demolishing or relocating site electrical items.
10. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver them to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

- C. Construction & Demolition Waste: Building and site improvement materials, and other solid waste resulting from construction, demolition, renovation, or repair operations. Material stream also includes brick, concrete, asphalt, and aggregate.
- D. Special Waste: Solid wastes that require special handling and management.
- E. Hazardous Waste: Any solid waste that is ignitable, corrosive, reactive, or toxic; a listed hazardous material or containing a listed hazardous material per Title 40 Code of Federal Regulations Parts 260-270.
- F. Universal Waste: Hazardous wastes that have been provided specific exemptions (40 CFR 273) to encourage recycling. Universal wastes are limited to recalled or cancelled pesticides and intact batteries, lamps, and mercury containing devices. State regulations prohibit the crushing of fluorescent lamps.
- G. Salvage: Recovery of waste for reuse in the existing facility, a different facility, subsequent sale as State Surplus property, or other reuse efforts.
- H. Recycle: Recovery of waste for processing and preparation into products or raw materials.
- I. Yard waste: A solid waste consisting solely of vegetative matter resulting from landscaping maintenance.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste remains property of Owner.
- 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 PRE-DEMOLITION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site 1081 Varsity Dr, Raleigh, NC 27606.
 - 1. Inspect and discuss condition of construction to be demolished.
 - 2. Review structural load limitations of existing structures.
 - 3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review and finalize protection requirements.
 - 5. Review procedures for noise control and dust control.
 - 6. Review procedures for protection of adjacent buildings.
 - 7. Review items to be salvaged and returned to Owner.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Waste Management Plan: The Contractor must provide a Waste Management Plan (<http://go.ncsu.edu/wastemanagementplan>) to NC State for approval prior to implementing work. The plan shall include details on how the hazardous and non-hazardous generated waste will be managed in accordance with local, state, and federal regulations. Contractor must also provide all materials, personnel, and protective equipment necessary to remove and store wastes in accordance with the plan. The Contractor must coordinate salvage or reuse efforts identified on the Designer Waste Information Form with NC State and/or the non-profit entity.
- D. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
 - 1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain including means of egress from those buildings.
- E. Schedule of Building Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
- F. Building Demolition Plans: Drawings indicating the following:
 - 1. Locations of temporary protection and means of egress for adjacent occupied buildings.
- G. Certificates
 - 1. Permits and notices authorizing demolition.
 - 2. Certificates of severance of utility services.
 - 3. Permit for transport and disposal of debris.
- H. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by building demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before the Work begins.
- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 CLOSEOUT DOCUMENTS

- A. Inventory: Submit a list of items that have been removed and salvaged.
 - 1. Hazardous Waste : provide Owner with a copy of all hazardous, universal, and special waste disposal certifications and/or manifests for all waste shipped.
 - 2. Non-Hazardous C&D Waste: All reuse, recycling, and landfilled materials shall be tracked and compiled on NC State's tracking forms (<https://recycling.ncsu.edu/wp-content/uploads/sites/3/2018/04/CD-Tracking-forms-for-upload.pdf>).

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

1.9 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
 - 1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
 - 2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
 - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
- C. Owner assumes no responsibility for buildings and structures to be demolished.
- D. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before building demolition, Owner will remove the following items:
 - a. Athletic equipment for reuse
- E. Hazardous Materials: The contractor shall be responsible for removal of construction demolitions containing hazardous materials. Refer to Division 01 section "Construction Waste Management & Disposal".
- F. On-site storage or sale of removed items or materials is not permitted.

1.10 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations or operations of adjacent occupied buildings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

2.2 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Division 31 Section "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
- D. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Pack or crate items after cleaning. Identify contents of containers.

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3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area designated by Owner.
5. Protect items from damage during transport and storage.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
 3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 4. Cut off pipe or conduit a minimum of **24 inches (610 mm)** below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
 5. Do not start demolition work until utility disconnecting and sealing have been completed and verified.
 6. Coordinate utility disconnecting and sealing with additional requirements in Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities.

3.4 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.
- C. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations.
1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
 - a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities and Controls."
1. Protect adjacent buildings and facilities from damage due to demolition activities.
 2. Protect existing site improvements, appurtenances, and landscaping to remain.

3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
 6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
 7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- E. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.5 DEMOLITION, GENERAL

- A. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 2. Maintain fire watch during and after flame cutting operations per the requirements of the Owner, of NFPA 51B and NFPA 241, of the authority having jurisdiction or as established by local ordinance, whichever is more restrictive.
 3. Maintain adequate ventilation when using cutting torches.
 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

3.6 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Salvage: Items to be salvaged are indicated below:
 - 1. Athletic equipment
- D. Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending **5 feet (1.5 m)** outside footprint indicated for new construction. Abandon below-grade construction outside this area.
 - 1. Remove below-grade construction, including basements, foundation walls, and footings, completely.
- E. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within **5 feet (1.5 m)** outside footprint indicated for new construction. Abandon utilities outside this area.
 - 1. Fill abandoned utility structures with satisfactory soil materials according to backfill requirements in Division 31 Section "Earth Moving."
- F. Hydraulic Elevator Systems: Demolish and remove elevator system, including cylinder, plunger, well assembly, steel well casing and liner, oil supply lines, and tanks.

3.7 SITE RESTORATION

- A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
- B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.8 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Division 01 Section "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Do not burn demolished materials.

3.10 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
 - 1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16

SECTION 02 41 19 - SELECTIVE DEMOLITION

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. This Section includes the following:

1. Demolition and removal of selected portions of building or structure
2. Demolition and removal of selected site elements
3. Salvage of existing items to be reused or recycled

- B. Related Sections include the following:

1. Division 01 Section "Summary" for use of premises and Owner-occupancy requirements.
2. Division 01 Section "Photographic Documentation" for preconstruction photographs taken before selective demolition operations.
3. Division 01 Section "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
4. Division 01 Section "Execution" for cutting and patching procedures.
5. Division 01 Section "Temporary Facilities and Controls" for disposal of non-hazardous demolition wastes.
6. Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of non-hazardous demolition wastes and for removal and storage of refrigerant.
7. Division 02 Section "Structure Demolition" for demolition of entire buildings, structures, and site improvements.
8. Division 22 Sections for demolishing or relocating site plumbing items.
9. Division 26 Sections for demolishing or relocating site electrical items.
10. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver them to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare them for reuse, and reinstall them where indicated.

- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- F. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, 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 encountered during selective demolition remain Owner's property.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PRE-DEMOLITION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For demolition firm, professional engineer, and refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.

5. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
7. Means of protection for items to remain and items in path of waste removal from building.

E. Certificates

1. Permits and notices authorizing demolition.
2. Certificates of severance of utility services.
3. Permit for transport and disposal of debris.

F. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before Work begins.

G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1. Comply with submittal requirements in Division 01 Section "Construction Waste Management and Disposal."

H. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

I. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT DOCUMENTS

- A. Inventory: Submit a list of items that have been removed and salvaged.
- B. Existing Warranties: Provide documentation at project closeout that existing warranties have been inspected as required and the warranty is still in effect.

1.8 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Owner will remove the following items:
 - a. Athletic equipment
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.
- E. Hazardous Material Removal: The responsibility to remove construction demolitions containing hazmats is defined as follows:
 - 1. Materials to be removed by the Owner include:
 - a. PCBs
 - b. Mold growth in existing structures.
 - c. Asbestos and crystalline silica
 - d. Radioactive materials and radon gas.
 - e. Explosives and existing containerized combustible materials, including paints.
 - 2. Materials to be removed by the Contractor include:
 - a. Lead paint, where identified as such by the Owner during bid, even if painted over.
 - b. Lead shielding
 - c. Lead flashing
 - d. Lead masonry plugs
 - e. Leaded glazes and ceramics.
 - f. Lead pipes and solder
 - g. Lead batteries
 - h. Mercury switches and thermostats.
 - i. Fluorescent tubes.
 - j. Halide lamps.
 - k. Mold growth in new construction.
- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by **12 inches (300 mm)** or more.
- G. Storage or sale of removed items or materials on-site is not permitted.

- H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.
- I. Protection of Existing Utilities: "Call Before You Dig." Contractor shall call 811 at least three days prior to any excavation work.

1.10 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Perform, or engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, preconstruction video and templates.
 - 1. Comply with requirements specified in Division 01 Section "Photographic Documentation."

2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- G. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
 1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
 3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."
- B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."
- C. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- D. Remove temporary barricades and protections where hazards no longer exist.
- E. Erect weatherproof closures for exterior openings. Maintain exit requirements.
- F. Erect and maintain dustproof partitions as required to prevent spread of dust, fumes and smoke to other parts of the building. On completion, remove partitions and repair damaged surfaces to match adjacent surfaces.
- G. During the removal of the existing parapets and roofing, provide proper protection from falling objects over entrances which are to be kept open during normal working hours.
- H. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
- I. Remove temporary barricades and protections where hazards no longer exist.
- J. Protection of Existing Utilities: "Call Before You Dig." Contractor shall call 811 at least three days prior to any excavation work.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations.
 5. Maintain fire watch during and after flame cutting operations per the requirements of the Owner, of NFPA 51B and NFPA 241, of the authority having jurisdiction or as established by local ordinance, whichever is more restrictive.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition **[and cleaned]** and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Cut concrete to a depth of at least **3/4 inch (19 mm)** at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers. Remove all underlayments and leveling materials to structural slab. Scarify concrete as required to remove all adhesive residue and prepare concrete for new underlayments, leveling materials or adhesive as may be required.
- F. Roofing: Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Refer to Division 07 Roofing Sections for new roofing requirements.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Division 01 Section "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
- B. Burning: Burning of demolished materials on site will not be permitted.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.9 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: None.
- B. Remove and Salvage: Historic scoreboard frieze and clock stored beyond center field.
- C. Remove and Reinstall: Athletic field lighting to be relocated at first base line.
- D. Existing Items to Remain: None.
- E. Dismantle: None.

END OF SECTION 02 41 19

SECTION 03 10 00 - CONCRETE FORMWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SCOPE:

A. Related Work Specified Elsewhere:

1. Concrete Reinforcement and Accessories (Section 03 20 00).
2. Cast-In-Place Concrete (Section 03 30 00).

B. Work Included In This Section:

1. Extent of formwork is indicated by the concrete structures shown on the contract drawings and as required to place concrete.
2. Work shall include (except as specified elsewhere in the contract documents) providing formwork and shoring for all cast-in-place concrete and installation into the formwork items furnished by others, such as anchors, plates, inserts, and any other items embedded in concrete.

1.3 INDUSTRY STANDARDS:

A. Reference: Some products and execution are specified in this section by reference to published specifications of standards of the following (latest edition, with respective abbreviations used):

American Concrete Institute (ACI)
The American Society for Testing and Materials (ASTM)
U. S. Product Standards (PS)

B. Standard Specifications and Codes: The following specifications and codes form a part of this specification:

Publications of the American Concrete Institute:

ACI 347	"Recommended Practice for Concrete Formwork"
ACI 117	"Standard Tolerances for Concrete Construction and Materials"

1.4 SUBMITTALS:

A. Manufacturer's Data: Submit (for information only) manufacturer's specifications for proprietary materials and items as required, including form coatings, formwork facing material, jointing, reveals, etc., ties, and accessories.

- B. Shop drawings for formwork structure, including the location of shoring and reshoring, are the responsibility of the Contractor and shall be submitted to the Engineer for information only.
- C. Product Data: For each of the following:
 - 1. Exposed surface form-facing material.
 - 2. Concealed surface form-facing material.
 - 3. Form liners.
 - 4. Form ties.
 - 5. Form-release agent.
- D. Sustainable Design Submittals
- E. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
 - 2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).
 - a. Location of construction joints is subject to approval of the Architect.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference.
 - 1. Review the following:
 - a. Special inspection and testing 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.

PART 2 – PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES:

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.

- d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 1/2 inches to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. 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.
- I. 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 (25 mm) to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) 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 DESIGN OF FORMWORK:

- A. The Contractor shall be responsible for the design of all concrete formwork. Formwork shall be designed in accordance with ACI 347 unless noted.
- B. Design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
- C. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
- D. Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities, and within allowable tolerances.
- E. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.
- F. Provide openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work.
- G. Fabricate 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 where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- H. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- I. Chamfer exposed corners and edges unless otherwise indicated, or specified, using wood, metal, PVC or rubber strips fabricated to produce uniform 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. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.

1. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 2. Concrete Exposed to view: Class A, 1/8 inch
 3. Unexposed Surfaces: Class B, 1/4 inch
 - L. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117.
 - M. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
 - N. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- 3.2 TOLERANCES: Formwork shall be constructed so as to ensure that the concrete surfaces will conform to the tolerances of Section 203.1 "Recommended Practice for Concrete Formwork" (ACI 347).
- 3.3 REUSE OF FORMS:
- A. Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.
 - B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.
 - C. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
 - D. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 - E. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- 3.4 CLEANING AND TIGHTENING: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is to be placed. Tighten forms immediately after concrete placement as required to eliminate mortar leaks.
- 3.5 FORM COATINGS:
- A. Coat form contact surfaces with form-coating compound before reinforcement is placed. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete

surfaces requiring bond of adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

- B. Do not allow excess form coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- 3.6 EMBEDDED ITEMS: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings or instructions, and directions provided by suppliers of the items to be attached.
- A. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - B. 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.
- 3.7 FORM REMOVAL: Formwork, not supporting concrete, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided that curing and protection operations are maintained. Formwork for surfaces specified to be "rubbed" is to be removed within 24 hours after placement. Immediately after rubbing, curing is to be reinstated.
- A. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
- 3.8 CONCRETE IN EARTH: Where trench excavation is used, and where sides of excavations are cut neatly in good, firm soil, side-forms may be omitted.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SCOPE:

A. Related Work Specified Elsewhere:

1. Concrete Formwork (Section 03 10 00)
2. Adhesive Concrete Anchors (Section 03 25 00)
3. Cast-In-Place Concrete (Section 03 30 00)

B. Work Included in this Section: Reinforcement for cast-in-place concrete (including bars, welded wire fabric, ties, and supports) as shown on drawings, and as specified herein.

1.3 QUALITY ASSURANCE:

A. References: Some products and execution are specified in this section by reference to published specifications or standards of the following (latest edition, with respective abbreviations used):

American Concrete Institute (ACI)

The American Society for Testing and Materials (ASTM)

American Welding Society (AWS)

Concrete Reinforcing Steel Institute (CRSI)

B. Standard References:

1. The current edition of the following standard references shall apply to the work of this section. Suffixes indicating date of issue are omitted from reference numbers used in the text of this section.

2. Publications of the American Concrete Institute:

ACI-301 "Specification for Structural Concrete for Buildings."

ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."

ACI 318 "Building Code Requirements for Reinforced Concrete."

3. Publications of the AWS:

AWS D1.4 "Recommended Practice for Welding, Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction."

4. Publications of the CRSI:

"Manual of Standard Practice"

5. Publications of the ASTM:

ASTM A-82 "Specification for Cold Drawn Steel Wire for Concrete Reinforcement."

ASTM A184 "Specification for Steel Bar Mats for Concrete Reinforcements."

ASTM A185 "Specification for Welded Steel Wire Fabric for Concrete Reinforcement."

ASTM A615 "Specification for Deformed Billet-Steel Bars for Concrete Reinforcement."

ASTM A706 "Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement."

C. Building Code: North Carolina State Building Code, current edition with all amendments.

1.4 SUBMITTALS:

A. LEED Submittals:

1. Product Data: For products having recycled content, documentation including percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data: For products being extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Include statement indicating cost for each product considered as a regional material.

B. Shop Drawings:

1. Shop drawings shall be in accordance with ACI 315.
2. Only shop drawings checked and stamped "Approved by Contractor" will be accepted for review.
3. Show details, bar clearances, notes, and necessary information for placing of reinforcing steel.
4. Show wall and pier reinforcing in elevation. Include all pertinent details and schedules required to specify the reinforcing. Show welding requirements for welded bars.
5. Submit reinforcing shop drawings for review. Shop drawings shall include, but not be limited to, reinforcing layout, size location, quantities, lap lengths,

required bends and other pertinent information related to the installation of the reinforcing steel.

C. Welding Certificates.

1.5 DELIVERY, STORAGE, HANDLING:

- A. Reinforcing steel shall be delivered to the project site properly tagged, bundled, and ready to place.
- B. Reinforcing steel and welded wire mesh delivered to project site (and not immediately placed in forms), shall be protected from mud, excessive rust-producing conditions, oil, grease, or distortion.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 90 percent.
- B. Regional Materials: Products to be used in the creation of the concrete mixes for the project shall be extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Provide a minimum of 20 percent of the products that qualify as Regional Materials.
- C. Reinforcing Bars: New, deformed bars, conforming to ASTM A615- S1, Grade 60 as required on drawings. ASTM A706 for bars in welded applications.
- D. Welded Wire Fabric: Welded wire fabric shall be electrically-welded, wire fabric of cold-drawn wire, of gauge and mesh as shown on drawings, or as required. Fabric shall conform to ASTM A185, Grade 60 or Grade 70. Provide in mat form.
- E. Plain Smooth Dowels: Plain smooth dowels shall conform to ASTM A306 with a minimum yield stress of 40,000 psi.
- F. Tie Wire: Shall be 16 gage, or heavier, black annealed, steel wire.
- G. Accessories: Fabricate accessories from concrete, metal, plastic, or other materials accepted by the Engineer. Include spacers, ties, chairs, bolsters, and other devices required to properly support, space, and secure the reinforcing steel in its proper position in accordance with the Drawings and recommendations of the CRSI "Manual of Standard Practice". Chairs and other accessories shall be Class I or Class II in accordance with CRSI. Parts in contact with exposed concrete surfaces shall be either stainless steel (AISI 302 or 304) or have plastic coated legs. Locations and types of accessories shall be shown on the shop drawings. Chairs for all concrete reinforcing steel to be supported on soil shall be continuous high chairs with continuous longitudinal wires, or individual square plates, welded to the bottom of the chair legs. Use "Z" spacer bars between adjacent vertical reinforcing mats in walls. Use standees between top and bottom mats of reinforcing in footings.

2.2 FABRICATION:

- A. Reinforcing steel shall be fabricated to shapes and dimensions indicated on drawings, and in compliance with applicable provisions of ACI 315 and ACI 318.
- B. Bars shall be bent cold in shop. No bars shall be bent in field, unless specifically indicated on drawings.
- C. Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:
 - 1. Sheared length: + one inch.
 - 2. Stirrups and ties: + one-quarter inch.
 - 3. All other bends: + one inch
- D. Fabrication of reinforcing steel prior to review and approval of shop drawings by Project Engineer shall be solely the responsibility of the Contractor.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR REINFORCING:

- A. Reinforcing shall be free from scale, loose rust, mud, or coatings which will reduce bond to concrete.
- B. Bars with kinks or bends not shown on drawings shall not be placed. Heating of reinforcement for bending or straightening will not be permitted.
- C. Minimum concrete cover for reinforcing shall be as shown on drawings and per ACI 318 standards, but otherwise shall comply with the following:
 - 1. 3" for concrete poured directly against the earth.
 - 2. 2" for formed surfaces exposed to earth or weather.
 - 3. 1" for formed slab or wall surfaces not exposed to weather.

3.2 PLACING OF REINFORCEMENT:

- A. Tolerances: Bars shall be placed to the following tolerance: + one-quarter inch.
- B. Dowels: Place steel dowels as required on drawings by means of plywood templates. Place and anchor dowels securely before placing concrete.
- C. Accessories:
 - 1. Nails shall not be driven into formwork to support reinforcement. Turn tie wires into concrete, not toward exposed surfaces.
 - 2. Space bar supports in accordance with ACI 315, ACI 301, and CRSI Manual of Standard Practice. Chairs for reinforcing steel to be supported on soil shall be

spaced as necessary to prevent the legs from pressing into the soil, but no more than 5'-0" on center.

3. In walls, provide continuous slab bolsters spaced at 4'-0" o.c. maximum to support reinforcing off formwork. Use #4 "Z" spacer bars at 4'-0" o.c. each way between wall mats.

D. Securing Reinforcement:

1. Reinforcing bars shall be supported and wired together to prevent displacement by construction loads, or by placing of concrete, beyond tolerances as set forth hereinbefore.
2. Maintain metal reinforcement securely and accurately in place until concrete is placed.
3. Any and all disturbances of reinforcement from any cause whatsoever shall be corrected fully prior to placing of concrete. Damaged bar-supports and spacers shall be repaired or shall be removed and replaced.
4. Bars shall not be bent after being embedded in hardened concrete, unless indicated so on drawings.
5. When approved, welding of reinforcing steel shall conform to AWS D1.4. Do not weld at bend in a bar. Welding of cross bars shall not be permitted unless authorized by Project Engineer.

3.3 SPLICES OF REINFORCEMENT:

- A. Splices and offsets in reinforcements shall not be made at points of maximum stress.
- B. Splices shall be approved by Engineer. Splices shall provide sufficient lap to transfer required stress.
- C. Character and design of each splice shall conform to requirements of ACI 318, Class B Tension laps, unless otherwise specifically noted on the drawings.

3.4 FIELD QUALITY CONTROL:

- A. Inspection of Placement of Reinforcing Steel:
 1. Project Engineer shall be given advanced notice of not less than 24 hours prior to placing concrete to allow inspection of reinforcing steel.
 2. Inspection of placement of reinforcement in a section will be made only after placement is complete for that section to be poured.
 3. Such inspections shall not relieve Contractor of his responsibility to provide work in accordance with requirements of contract documents. Such inspections are for purpose of minimizing errors in field work.

END OF SECTION 03 20 00

SECTION 03 25 00 - ADHESIVE ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Furnishing and installing adhesive anchors as dowels or with washers and nuts into holes drilled into the existing cast-in-place concrete members as indicated on the drawings and as specified herein.
- B. Equipment required for drilling the holes and for locating the existing embedded reinforcing steel.
- C. Equipment required for mixing, proportioning and dispensing the adhesive into holes drilled for adhesive anchors.
- D. Identifying and locating existing reinforcing steel with magnetic equipment, pilot holes, or other means prior to drilling holes for anchors.
- E. Items of testing, quality control, and evaluation of in-place adhesive anchors.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE:

- A. Cast In Place Concrete (Section 03 30 00)
- B. Structural Steel (Section 05 12 00)

1.3 QUALITY ASSURANCE:

- A. References: Some products and execution are specified in this section by reference to published specifications or standards of the following (latest edition, with respective abbreviations used):
 - American Society for Testing and Materials (ASTM)
 - American Institute of Steel Construction (AISC)
 - American Concrete Institute (ACI)
- B. Standard Specifications and Codes: The following latest edition of the specification and codes form a part of this specifications where reference is made to a specific paragraph or section of the specific standard or code:

- ACI 503.1 "Standard Specification for Bonding Hardened Concrete, Steel, Wood, Brick, and Other Materials to Hardened Concrete with a Multi-Component Epoxy Adhesive"
- ACI 318 Building Code Requirements for Reinforced Concrete
- ACI 349 Appendix 'B' "Steel Embedments"
- ASTM E488 "Standard Test Methods for Strengths of Anchors in Concrete and Masonry"

C. Building Code: North Carolina State Building Code

1.4 SUBMITTALS:

A. LEED Submittals:

1. Product Data: For epoxy and other adhesive anchoring systems, documentation including printed statement of VOC content.

B. Submit test results performed by an Independent Testing Laboratory certifying tensile, bond, and shear strength of anchors specified herein or shown on the contract drawings. Tests of anchors shall be made on nearly identical materials, embedment lengths, and conditions indicated on the drawings. Tests shall be made in accordance with ASTM E488 "Standard Test Methods for Strength of Anchors in Concrete and Masonry".

C. Anchors acceptable for use on this project shall meet or exceed the load test data as required by the Contract Drawings.

D. Submit copies of the manufacturer's written instructions for installation of the adhesive anchors specified.

E. Submit type of equipment to be used for drilling the holes in the concrete for the adhesive anchors, and procedures for drilling and preparation of the holes for receiving the adhesive anchors.

F. Submit type of equipment to be used for proportioning, mixing, and dispensing the adhesive.

G. Certification that the adhesive will not be affected by the alkalinity of the cement and that there is no shrinkage of the adhesive, and that the creep coefficients are insignificant.

1.5 QUALIFICATIONS:

A. Manufacturer:

Source: Adhesive for bonding the anchors into the existing concrete shall be of one manufacturer unless specifically noted otherwise herein.

- B. Installer Training: Conduct thorough on-site training with the manufacturer or the manufacturer's representative for the contract on the project. Anchors installed prior to completion of the training will be rejected and subject to load testing at contractor's expense or removal and replacement. Training to consist of a review of the complete installation process for each type of epoxy embedded anchor types, to include but not limited to:
 - 1. Hole drilling procedure
 - 2. Hole preparation & cleaning technique
 - 3. Adhesive injection technique & dispenser training / maintenance
 - 4. Anchor preparation and installation
 - 5. Proof loading/torquing

- C. Certifications: Unless otherwise authorized by the Engineer, anchors shall have one of the following certifications:
 - 1. ICBO ES Evaluation Report indicating conformance with current applicable ICBO ES Acceptance Criteria.
 - 2.. ICC ES Evaluation Report

1.6 PRODUCT HANDLING:

- A. Delivery and Storage: Deliver all materials of this section to the job site in original unopened containers with all labels intact. Store only under conditions recommended by the manufacturer. Do not retain on the job site any material that has exceeded the shelf life recommended by the manufacturer.

- B. Replacement: In the event of damage, replace as necessary to the approval of the Engineer at no additional cost to the Owner.

PART 2 - PRODUCTS

- 2.1 ACCEPTABLE MANUFACTURERS: Only products of the following manufacturer will be acceptable for use on this project when approved by the Engineer and the results of all tests on products proposed by the manufacturer meets all the requirements of these specifications:
 - A. DeWalt – Formally Powers Fasteners of New Rochelle, NY

 - B. Hilti of Tulsa, OK

 - C. Simpson Strong-Tie of Pleasanton, CA

2.2 MATERIALS:

A. Anchor Rods and Dowels:

1. Anchor rods shall be stainless steel manufactured from steel conforming to ASTM F593 (AISI 304), unless otherwise noted on the drawings. Anchor rods shall have minimum depth of embedment as indicated on details. Anchor rods shall have threads for their full length.
2. Dowels shall be the same material as anchor rods or reinforcing steel as specified on the Contract Drawings.

B. Nuts and Washers: Nuts shall be manufactured from steel conforming to ASTM F594. All washers and nuts shall conform to ANSI B18.22.1 (1965) Type A plain.

C. Adhesive Injection Gel: shall be a two-component solvent-free, moisture-insensitive, creep resistant paste epoxy bonding agent for bonding rigid materials exposed to sustained loads and/or high ambient temperatures.

1. Quality Control: Quality control tests are required on each lot of adhesive supplied under this specification.
 - a. Testing: All tests shall be conducted using the test methods prescribed in Sections 2.0 and 3.0.
 - b. Tests: The actual quality control tests to be performed in accordance with ASTM standards and the manufacturer's written instruction.
 - c. Certification and Test Report: Manufacturer shall certify that every batch of material supplied to this specification meets all of the requirements of Sections 2.0 and 3.0.
2. Labeling, Packaging, Storage:
 - a. Labeling Information: The label shall include, in a clear and distinct manner, the following information:
 - (1) Product name and lot number
 - (2) Health hazard warnings, precautions or handling and recommended first aid procedures in cast of contact
 - (3) Mix ratio by volume
 - (4) Directions for use
 - b. Packaging: The adhesive material shall be packaged in new, sealed containers. Each container will be clearly labeled.

- c. Storage: The material shall be stored in its original sealed containers at a temperature not below 32°F or above 90°F for a period not to exceed 1 year. If these limits are exceeded, the material shall be retested prior to use to determine conformance to this specification. The expense of any retest shall be borne by the purchaser.
- D. Drilling Equipment: Per manufacturer written instructions specific to the type of anchoring and adhesive system being used for the appropriate conditions.
- E. Equipment for Dispensing:
 - 1. Bulk Mix and Dispensing:
 - a. Type: The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the hole or void shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electrically powered to supply the logic controller and air powered to drive the individual pumps, and shall provide in-line mixing.
 - b. Operating Pressure: Air input pressure from compressor is limited to 100 psi maximum. Pump shall have a 50 to 1 mechanical advantage ratio, thus giving up to 5000 psi discharge pressure when input pressure reaches 100 psi. Face shields and gloves are mandatory for operator of pump during operation of pump. 40 psi is standard operating pressure of compressor. At higher temperatures, line pressure can be reduced.
 - c. Ratio Tolerance: The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of + 5% by weight at any volume delivery and discharge pressure. Pump shall be adjustable ratio from 1:1 to 3:1 within 5% accuracy by weight.
 - 2. Hand Mix and Dispensing:
 - a. Mixing: Measuring and mixing for small quantity dispensing may be accomplished by measuring correct amounts of adhesive components into a container and mixing as directed by the adhesive manufacturer.
 - b. Dispensing: Properly mixed adhesive shall be loaded into a bulk caulking gun and dispensed into the holes. The nozzle of the caulking gun shall be long enough to begin dispensing the adhesive into the hole beginning at the bottom or rear of the hole.

PART 3 - EXECUTION

3.1 PROJECT EXAMINATION:

- A. Prior to the installation of any adhesive anchors, the Contractor shall examine the site and all concrete surfaces and members to receive the anchors and identify conditions which adversely affect the execution of the work. Prior to beginning this work, the manufacturer of the epoxy shall provide instructions and technical assistance to the personnel installing the anchors on the procedures for drilling and installing the anchors. Unless waived by the Engineer based upon demonstrated past experience in epoxy anchor installation, this instruction shall be on site. **Only a contractor or subcontractor who has been trained and approved by the epoxy manufacturer will be permitted to install the adhesive anchors on this project.**
- B. Do not proceed with work until all unsatisfactory conditions have been corrected and the personnel have been properly trained on drilling and installing the anchors.

3.2 HOLES FOR ANCHORS:

Locating Holes: All holes shall be accurately located and as near as possible to the location shown on the contract drawings to miss the existing reinforcing steel. Where holes have to be shifted due to job conditions more than 1" from the location shown or closer than 1" from the edge of the steel plate connection or angle, notify the Engineer.

3.3 EXECUTION OF THE WORK:

- A. Drilling of Holes: All holes shall be drilled using only the manufacturer recommended and approved equipment to the specified depth and diameter recommended by the manufacturer for the size of anchor specified. Use a depth gage to drill hole to the specified depth. Holes shall be clean with minimal side wall residue. All holes shall be thoroughly clean of all dust, debris, and other bond inhibiting contaminants using methods and procedures recommended by the manufacturer. Holes shall be cleaned using oil-free compressed air and nylon brushes. Holes shall be approved prior to installing the adhesive gel.
- B. Unless waived by the Engineer, all holes shall be inspected and approved by the Engineer or a representative of the testing laboratory/Special Inspector prior to the installation of the anchor. Acids shall not be permitted for cleaning.
- C. After cleaning, adhesive and anchor bolts shall be placed immediately to prevent contamination of the concrete and metal.
- D. Holes that are drilled and abandoned shall be filled with a moisture insensitive epoxy mortar. Where exposed, tint the epoxy mortar to match the mortar color of the adjacent surfaces.
- E. Dispensing of adhesive shall begin at bottom or back of hole or void. Upon filling the hole with adhesive, the adhesive shall displace the fitting and pipe nozzle from the hole, without travel of adhesive past the fitting.

- F. Anchor rod holes shall be filled to half to three-quarters the depth of the hole to ensure full depth contact of adhesive and anchor rod.
- G. Placing of the anchor rod should be done with one continuous stroke. Rotate the anchor or dowel as it is placed to ensure that all surfaces will be in intimate contact with the adhesive. The anchor or dowel shall not be moved back and forth, as this will entrap air, as does excessive turning of the anchor.
- H. Once the anchor rod is installed, wooden shims or bent wire shims shall be placed below the bolt to keep it centered in the hole. In addition to shimming, use other approved means to keep it centered in the back of the hole.

3.4 FIELD QUALITY CONTROL:

- A. Testing: 5% of each type and size of drilled-in anchor shall be proof loaded by an independent testing laboratory. Testing of the anchors shall be performed prior to installation of other work attaching to or around the anchors. Adhesive anchors shall not be torque tested unless otherwise directed by the Engineer. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer. The cost of these additional tests shall be borne by the Contractor.
 - 1. Torque shall be applied with a calibrated torque wrench.
 - 2. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed $D/10$, where D is the nominal anchor diameter.

3.5 CURING: Curing for all anchors shall be as recommended by the manufacturer for the environmental condition at the time the anchor is installed.

3.6 WORKMANSHIP: Remove and replace any anchor that does not meet all the requirements of these specifications at no additional cost to the Owner.

END OF SECTION 03 25 00

SECTION 03 30 00 - 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 1 Specification Sections, apply to this Section.

1.2 SCOPE:

Section includes cast-in-place concrete as shown on drawings, as specified herein and as required to complete this work, including formwork, reinforcement, concrete materials, mixture design, mixing, transporting, placing, finishing, curing, quality control, quality assurance and property evaluation for the following.

1. Slabs on grade.
2. Foundations.
3. Building walls and piers
4. Slab on steel decking

B. Related Work Specified Elsewhere:

1. Concrete Formwork (Section 03 10 00)
2. Concrete Reinforcement (Section 03 20 00)
3. Adhesive Anchors (Section 03 25 00)
4. Steel Decking (Section 05 31 00)

1.3 DEFINITIONS:

- A. Cementitious Materials: Materials conforming to this specification and have cementing value when used in concrete either by themselves, such as portland cement, other hydraulic cements or blended hydraulic cements, or such materials in combination with fly ash, other raw or calcined natural pozzolans, silica fume and/or slag cement.
- B. Concrete: Mixture of cementitious materials, aggregates and water, with or without fibers or chemical admixtures, as required by this specification.

1.4 INDUSTRY STANDARDS:

- A. Some products and execution are specified in this section by reference to published standards of the following:

American Concrete Institute (ACI)

American Society for Testing and Materials (ASTM)

American Welding Society (AWS)

Concrete Reinforcing Steel Institute (CRSI)

National Ready-Mix Concrete Association (NRMCA)

1.5 MANDATORY REFERENCED STANDARDS:

- A. When referenced in text, standards and codes applying to this work shall conform to the latest version. Suffixes indicating date of issue are omitted in text.
- B. Work on this project shall conform to all requirements of the following documents, published by the American Concrete Institute, Farmington Hills, except as specifically modified by these Contract Documents. Where conflicts arise between mandatory references, the more stringent requirement shall apply. Suffixes indicating date of issue are omitted elsewhere in text.

ACI 117-06 Specifications for Tolerances for Concrete Construction and Materials

ACI 301-05 Specification for Structural Concrete – Sections 1-5

ACI 305.1-06 Specification for Hot-Weather Concreting

ACI 306.1 -90 Standard Specification for Cold-Weather Concreting

ACI 308.1 -98 Standard Specification for Curing Concrete

1.6 SUBMITTALS:

- A. Submittals are to include information required by MANDATORY REFERENCE STANDARDS in addition to information below.
- B. Product Data and MSDS: For each type of product indicated.
- C. Design Mixtures:
 - 1. For each concrete mixture, submit the proposed mixture design with information necessary to support conformance to these specifications. Submit alternate design mixtures at no additional cost to the owner, when characteristics of materials, Project conditions, weather, test results, material availability, design expiration per these documents or other circumstances warrant adjustments or re-design.
 - 2. Submit third party fresh and hardened concrete testing results demonstrating conformance of the mixture to this specification.
 - 3. Submit material certificates, material quality control information and samples per this specification.
 - 4. Indicate ranges of admixtures for production concrete and amounts of mixing water to be withheld for later addition at Project site (if approved by Engineer)

D. LEED Submittals:

1. Product Data: For products having recycled content, documentation including percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data: For products being extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Include statement indicating cost for each product considered as a regional material.
3. Product Data: For liquid floor treatments and curing and sealing compounds, documentation including printed statement of VOC content.
4. Design Mixtures: For each concrete mixture containing fly ash as a replacement for Portland cement or other potential cement replacements, and for equivalent concrete mixtures that do not contain Portland cement replacements.

E. Concrete Production Field Quality Control Reports (Submitted monthly to Engineer):

1. Submit material certificates, field quality control information and samples per this specification.

F. Steel Reinforcement Shop Drawings: Refer to Section 03 20 00.

G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure, if not otherwise indicated on the drawings.

1. Location of construction joints is subject to approval of the Engineer.

H. Samples: For concrete materials, collected in accordance with ASTM C 183 and ASTM D 75, if requested by the Engineer.

I. Qualification Data: For installers, manufacturers, producers and testing agencies.

J. Material Certificates: For each of the following, signed by manufacturers demonstrating conformance to applicable standards and this specification:

1. Cementitious materials.
 - a. Report alkali contents for supplementary cementitious materials.
2. Admixtures
 - a. To include compatibility statements for each admixture to document appropriateness for use with other constituents.
3. Aggregates
4. Waterstops.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

- K. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements (as necessary to satisfy requirements for each individual mixture design proposed for the work):
 - 1. Historical and current quality control test records for cementitious materials and aggregates.
 - 2. Aggregate testing data and indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity for all mixtures.
- L. Quality Control Plan, Plan of Action And Quality Control Records
- M. Minutes of pre-installation conference
- N. Repair procedures
- O. Floor surface flatness and levelness measurements to determine compliance with specified tolerances, if requested.
- P. Indicate proposed construction joints required to construct the structure.
- Q. Samples of concrete materials collected in accordance with ASTM C 183 and ASTM D 75, if requested.

1.7 QUALITY ASSURANCE:

- A. Superintendent: Qualified superintendent with at least 5 years experience with similar types of concrete placements.
- B. 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.
- C. Cementitious Materials Testing Agencies: Testing for cementitious materials as part of the quality control plan and for material certification must be conducted by agencies that have participated in the reference sample and laboratory inspection programs of Cement and Concrete Reference Laboratory (CCRL). Proof of participation and current involvement is required.
- D. Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- E. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
 3. Laboratory testing for hardened concrete other than compressive strength testing shall be a firm specializing in the specific test(s).
- 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. Comply with the Mandatory Reference Standards Above unless modified by requirements in the Contract Documents:
- H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- I. Pre-installation Conference:
1. At least 15 days before submitting design mixtures, hold a pre-construction conference to review the design mixture and detailed procedures for ensuring quality of concrete material and proper concrete construction. Provide a detailed quality control plan for procedures and testing meeting the requirements of these specifications. Record detailed minutes of the meeting and distribute to all parties in attendance within five (5) days. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendents.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Independent testing agency responsible for field quality assurance testing.
 - d. Ready-mix concrete manufacturer.
 - e. Concrete subcontractor.
 - f. Special concrete finish subcontractor
 - g. Reinforcing installers
 - h. Designer
 - i. Special Inspector
 - j. Other involved parties
 2. Review Quality Control Plan

1.8 CONTRACTOR QUALITY CONTROL

- A. The Contractor must implement a quality control plan:
1. Contractor shall designate persons or third party to perform quality control. Testing shall be done by persons qualified per these specifications.
 2. Procedures
 - a. Special inspection and testing and inspecting agency procedures for field quality assurance, contractor quality control, concrete finishes and finishing procedures, curing procedures, construction contraction and isolation joints, and joint-filler

strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, concrete protection, workforce, placement logistics and contingencies for equipment failures or inclement weather, material transportation to site, verification of subcontractor and producer work and/or materials.

3. Production Testing
 - a. Frequency for testing to verify fresh concrete property conformance in production shall be included in the Quality Control Plan. Quality control records shall be submitted.
4. Concrete Production Facilities
 - a. Provide plan and records for demonstrating conformance to ASTM C 94 and must have current NRMCA “Certification of Ready Mixed Concrete Production Facilities” for the batch plant and fleet.
5. Cementitious Materials
 - a. Mill certifications must be current and contain all standard and optional compositional and physical data (per associated ASTM standard) demonstrating conformance. Cementitious Materials Producer quality control testing frequency must be daily (maximum) unless otherwise approved by the Engineer and shall demonstrate compliance with specifications. The general procedures for testing and reporting shall follow ASTM C 1451 or other approved method.
 - b. Historical mill certifications and producer quality control/uniformity records for specified properties (per the applicable ASTM standard) of all cementitious materials for a period dating from the time of design to six months prior to design.
 - c. Mill certifications and producer quality control/uniformity records for all cementitious materials.
6. Aggregates
 - a. Quality control testing must be at a frequency no greater than daily for coarse and fine aggregate cleanliness (ASTM C 117) and coarse aggregate grading (ASTM C 136) and twice per day for fine aggregate gradation (ASTM C 136). The general procedures for testing and reporting shall follow ASTM C 1451 or other approved method. Sampling locations shall be detailed in the quality control plan and shall represent conditions in the mixture.
 - b. Method and frequency of moisture content testing shall be detailed in the quality control plan. In-line moisture meters for fine aggregate, if used, must be calibrated at least once per shift, minimum. Moisture content of coarse aggregates must be tested at least once per day or when conditions change. Fine aggregates must be tested once every four (4) hours minimum, or when conditions change.
 - c. Include contingency procedures for adverse weather conditions at stockpiles and methods to maintain consistency in materials.
 - d. Historical aggregate quality control data demonstrating conformance to specifications for a period dating from the time of design to six months prior to design.
 - e. Quality control data for coarse and fine aggregates during construction.
 - f. Quality control plan for use of non-standard aggregate gradations if appropriate.
7. Concrete Design Trial Mixtures and Production Mixtures
 - a. Records of all concrete trials and placements showing exact location of placement, date and time of placement, site-specific environmental conditions during placement, including relative humidity, air temperature and wind speed as required in these specifications, quantity of placement, class of concrete placed, curing temperatures, verification of moist curing measures and other quality control

records. Submit mandatory and optional batch ticket information listed in ASTM C 94 Section 13 for each concrete batch. Provide clear indication of materials added to the concrete mixture.

- b. Indicate ranges of admixtures for production concrete and amounts of mixing water to be withheld for later addition at Project site (if approved by Engineer)

1.9 DELIVERY, STORAGE, AND HANDLING:

- A. All materials to be stored per manufacturer's written requirements and in a manner to prevent contamination, damage, or degradation.

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. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 CONCRETE MATERIALS:

- A. Regional Materials: Products to be used in the creation of the concrete mixes for the project shall be extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Provide a minimum of 20 percent of the products that qualify as Regional Materials.
- B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project unless approved in writing by the Engineer:
 - 1. Portland Cement: ASTM C 150, Type II or Type I/II, gray, low Alkalai. Use Type V gray, if indicated or directed when concrete is in contact with sulfate in soil or water. The following supplemental cementitious materials are permitted for use:
 - a. Supplementary Cementitious Materials (SCM's):
 - 1) Fly Ash: ASTM C 618, Class F. Loss on ignitions (LOI) shall not be greater than 3% and shall not vary by more than +/- 1%. Fly ash shall meet the optional physical requirements of ASTM C 618. Historical ASTM C 1451 uniformity records for a period of at least six months prior to design and throughout construction from the producer must demonstrate conformance.
 - 2) Slag Cement: ASTM C 989, Grade 80 or Grade 100. Slag cement shall not qualify as Grade 120 unless permitted by the Engineer in writing.

- 3) Silica Fume: ASTM C 1240, including optional physical uniformity requirement.
 - 4) Other SCM's conforming to ASTM C 618 may be submitted for evaluation.
2. Blended Hydraulic Cement: When permitted, ASTM C 1157 Cement Type GU, MS, MH, or ASTM C 595, Type IS, portland blast-furnace slag, Type IP, portland-pozzolan cement, or Type IL, Portland-limestone cement. Conform to maximum supplementary cementitious materials content in the blended cement provided in ACI 301 if exposed to deicing salts.
- C. Aggregates: Provide individual aggregates from a single source throughout the project. Each source shall be individually stockpiled and handled in a manner to minimize segregation. Provide service record data of at least 10 year's satisfactory service in similar application and service conditions using similar aggregates and cementitious materials. Aggregate sources that exhibit potential for alkali-silica reactivity with proposed cementitious materials shall not be used. Provide documentation that one of the two following criteria are met, as tested by a qualified third party laboratory on a representative sample of each aggregate source:
1. ASTM C 1260 mortar bar expansion is less than 0.13 percent at 28 days
 2. ASTM C 1567 mortar bar expansion with job cementitious materials is less than 0.13 percent at 28 days. ASTM C 1567 to be used only if the sodium oxide equivalent alkalis are less than 4 percent in supplementary cementitious materials. Alternative approved methods to be used if requirement not met.
- D. Normal-Weight Aggregates: ASTM C 33 coarse and fine aggregates, Class 4M coarse aggregate or better, graded, unless otherwise permitted. Use Class 5M coarse aggregate for architectural concrete, as specified, unless otherwise permitted by the Engineer. Aggregate certification is valid for 90 days from the date of testing. Quality control records for gradation and cleanliness shall not exceed ASTM C 33 limits more than once in five consecutive tests prepared for quality control, except that the fine aggregate fineness modulus shall not deviate more than 0.2 from the base fineness modulus per ASTM C 33 for any test.
1. Nominal maximum size of coarse aggregate. Nominal maximum sizes indicated in mixture design requirements shall be used, provided that requirements of ACI 301 are met:
 2. Fine Aggregate shall conform to the specific sieve analysis limits of ASTM C 33 Section 6 unless otherwise permitted. Fine aggregates shall be clean, sharp, natural and free from loam, clay, lumps or other deleterious substances.
 3. The gradation limits of ASTM C 33 may be waived at the discretion of the Engineer provided that it can be demonstrated that a more optimal gradation is achieved and gradation control can be maintained. Intermediate sized aggregates may be used. Documentation of optimization should include Individual Percent Retained Chart, Coarseness Factor Chart, 0.45 Power Curve, and dry-rodded unit weight testing. Submit information to show method used and plan for quality control if alternate gradations are used.
- E. Water: ASTM C 94 and potable, or ASTM C 1602.
- F. Fly ash shall be obtained from one source for the concrete delivered to the project. Fly ash may be allowed to replace up to 40% of the cement by weight. If Fly ash is used, a minimum of 20% percent of fly ash, by weight of cement, shall be used to replace cement.

1. Fly ash is not permitted in concrete placed subject to cold weather placement procedures (ASTM C306).
2. Fly ash will not be permitted for concrete exposed to the weather or the exterior, or concrete mixes with entrained air. Except where air content is measured and verified (by the appropriate ASTM Standard Test Method) to be within specified tolerances for each truck immediately prior to placement and as approved by architect. The coordination and cost of such testing shall be the contractor's responsibility except as approved by the owner. Concrete not conforming to the requirements of the specifications shall be rejected.

2.3 ADMIXTURES:

- A. All admixtures shall be used in strict conformance with manufacturer's written requirements. Manufacturer(s) must certify that admixtures are compatible with other constituents in mixture. Admixtures shall be used as indicated in drawings, permitted by the Engineer, or necessary for design, as applicable. All admixtures are subject to approval by the Engineer.
- B. Air-Entraining Admixture: Air entraining admixture shall conform to ASTM C 260. The Contractor shall submit an alternative if appropriate due to compatibility issues with other admixtures.
- C. Chemical Admixtures: 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. All admixtures shall be non-corrosive and contain only trace amounts of deleterious halides. All admixtures shall be from a single source unless otherwise permitted by the Engineer.
 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.
 7. Accelerating or Water-Reducing and Accelerating Admixtures: ASTM C 494 Type C or E, respectively, shall be non-chloride, non-corrosive, and only used if permitted by the Engineer in writing.
- D. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C. Use only if permitted by the Engineer in writing.
 1. Products: Subject to compliance with requirements:
 - a. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI.
 - c. Sika Corporation; Sika CNI.

- E. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete. Use only if permitted by the Engineer in writing. Available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Products: Subject to compliance with requirements:
 - a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI-S.
 - c. Sika Corporation; FerroGard 901.
- F. Specialty admixtures including shrinkage-reducing admixtures (SRA), alkali-silica reaction inhibiting admixtures (ASRIA), viscosity-modifying admixtures (VMA) and durability Enhancing Admixtures (DEA) must have data documenting their effectiveness and compatibility with other admixtures, have a proven field history with similar job materials and be approved by the Engineer.
 - 1. Self-Consolidating concrete (SCC): High-range water reducing admixture shall conform to ASTM C 494 Type F (or ASTM C 1017 Type I), be polycarboxylate-based, and appropriate for use in SCC, as indicated by the manufacturer.

2.4 CURING MATERIALS:

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry, clean and free of materials injurious to cement or concrete or that will mar the surface. Burlap shall be stored dry and rinsed with clean water prior to application.
- B. Moisture-Retaining Cover: ASTM C 171, 10- mil polyethylene film or white burlap-polyethylene sheet. Use black when required per ACI 308.1
- C. Water: Clean, potable and non-chloride bearing.
- D. Curing Compounds shall not be used unless permitted in writing by the Engineer. If permitted, the type with supporting documentation and proposed area shall be submitted to the Engineer for review. If used at an area to receive coating or adhered membrane, compound must be certified by manufacturer to not interfere with bonding of floor covering.
 - 1. Clear, Waterborne, Non-staining, Membrane-Forming Curing Compound with Fugitive Dye: ASTM C 309, Type 1-D, Class B
 - 2. Clear, Waterborne, Non-staining, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type II, Class A.
 - 3. White, Waterborne, Non-staining, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type II, Class A.

2.5 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. Do not place asphaltic materials in contact with PVC, separate with EPDM.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80, or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 per ASTM D 2240.
- 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 suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.0217-inch- thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- G. Waterstops:
 - 1. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - a. Profile: Flat dumbbell with center bulb
 - b. Dimensions: 6 inches by 3/8 inch thick nontapered.
 - 2. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
 - a. Profile: Flat dumbbell with center bulb
 - b. Dimensions: 6 inches by 3/8 inch thick nontapered.
 - 3. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - a. Profile: Flat dumbbell with center bulb
 - b. Dimensions: 6 inches by 3/8 inch thick nontapered.
- H. Vapor Retarders
 - 1. Sheet Vapor Retarder: ASTM E 1745, Class A, 10 Mil minimum thickness, unless otherwise noted on the drawings. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.6 REPAIR MATERIALS:

- A. Repair Materials shall have documentation to show compatibility with substrate materials, shall be specially formulated and proportioned for the specific use, and shall provide a durable repair. Conform with ACI 301.

2.7 CONCRETE MIXTURES, GENERAL:

- A. Prepare design mixtures for each type of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. Submit written reports of each proposed mix for each class of concrete prior to start of work to document that requirements have been met. Include up to date sieve analyses and concrete strength tests. Do not begin concrete production until mixes have been reviewed and approved by the Engineer.
 - 1. Concrete mixture designs shall be considered valid for 183 days from the date of trial batching. Mixtures shall be re-certified through testing prior to concrete placement after the expiration date.
 - 2. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 - 3. Unless otherwise noted or permitted by the Engineer, strength requirements shall be based on 28-day compressive strength tests in accordance with ACI 301.
 - 4. Required compressive strength of the design mixture shall be based on statistical methods or laboratory trial requirements to exceed the specified concrete compressive strength. All other required hardened concrete properties specified for design shall be based on actual test values.
 - 5. Design mixes shall be proportioned using the maximum specified slump and within 3 °F of the maximum temperature to be used during production. Trials used to prepare specimens for mixture qualification shall be completed with full scale trucks with at least 5 cubic yards of concrete and in a manner similar to that expected during production. Material proportions for the trial shall be used as the basis for tolerances in production. Method of placement shall be considered and accounted for in developing the mixture design.
 - 6. If a self-consolidating concrete mixture is proposed for use, the Contractor must submit the mixture design, appropriate documentation for fresh concrete properties and stability and hardened concrete stability for review. An on-site program must be proposed for quality control.
- B. Cementitious Materials: Conform to ACI 301. Use fly ash, pozzolan, ground granulated blast-furnace slag, silica fume or other supplementary cementitious materials as needed to achieve required properties.
 - 1. Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - a. Fly Ash: 20 percent minimum (if using), 40 percent maximum.

- C. Limit acid-soluble, chloride-ion content in hardened concrete to 0.08 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions. Do not use admixtures that have not been incorporated and tested in the accepted mixtures, unless otherwise authorized by the Engineer in writing.
 - 1. Use water-reducing, high-range water-reducing or plasticizing admixtures in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures or other adverse placement conditions.
 - 3. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 - 4. Do not use accelerating admixtures unless permitted by the Engineer in writing.
 - 5. Use of admixture is subject to approval by the Engineer.
- E. Air entraining admixtures shall be used for all concrete potentially exposed to freezing and thawing or subjected to hydraulic pressure.
 - 1. Entrained air shall be 6% +/- 1.5%. The water cement ratio for all concrete exposed to freezing and thawing shall not exceed 0.45.

2.8 SLUMP:

- A. Concrete shall be proportioned to have a specified slump of 4" at point of placement (with applicable tolerances) unless otherwise permitted. Requests shall be submitted to the engineer. Lower or higher values may be used if indicated by the Contractor and the Contractor can demonstrate the mixture can be well placed and consolidated during the mock-up without segregation.
- B. Concrete containing high range water reducers shall have at least 2" of initial slump prior to addition of high range water reducing admixture. Slump shall not at any time exceed 8" after addition of admixtures, unless otherwise approved. All admixtures shall be added at the plant unless otherwise permitted in writing by the Engineer. Only if permitted, the addition of the high range water reducer shall be by a truck mounted mechanical dispenser or by a qualified certified concrete technician of the concrete supplier. The admixture shall not be manually dispensed by the concrete truck driver. After the addition of the high range water reducer, the concrete shall be rotated at maximum speed for a minimum of three minutes (45 revolutions minimum). The contractor must demonstrate that concrete properties are not adversely affected by on-site addition. Specific quality control measures must be proposed by the Contractor.
- C. Concrete containing water reducers, other than high range water reducers, shall have a maximum slump of 6 inches and a minimum slump of 3".

2.9 CONCRETE MIXTURES FOR SITE ELEMENTS:

- A. Foundations for Building (Spread Footings and Wall Footings): Proportion structural normal weight concrete as follows:
 - 1. Nominal Maximum Size Coarse Aggregate: 3/4-inches.

2. Minimum Design Compressive Strength, f'_c (ASTM C 39): 3000 psi at 28 days (provide applicable data to substantiate the chosen required f'_{cr})
 3. Maximum Water-Cementitious Materials Ratio: 0.50
 4. Air Content at Point of Placement (ASTM C 173): 3 percent max
 5. Maximum Allowable Slump at Point of Placement (ASTM C 143): 4" min, 6" max
 - a. Exception: see requirements for addition of high range water reducer for concrete to be pumped into place.
- B. Interior Slab-on-Grade: Proportion structural normal-weight concrete as follows:
1. Nominal Maximum Size Coarse Aggregate: 3/4-inches.
 2. Minimum Design Compressive Strength, f'_c (ASTM C 39): 4000 psi at 28 days (provide applicable data to substantiate the chosen required f'_{cr})
 3. Maximum Water-Cementitious Materials Ratio: 0.50
 4. Air Content at Point of Placement (ASTM C 173): 3 percent max
 5. Maximum Allowable Slump at Point of Placement (ASTM C 143): 4" min, 6" max
 - a. Exception: see requirements for addition of high range water reducer for concrete to be pumped into place.
- C. Slab on steel decking, including composite slabs: Proportion structural normal-weight concrete as follows:
1. Nominal Maximum Size Coarse Aggregate: 3/4-inches.
 2. Concrete Unit Weight: Maximum 120 pounds per cubic foot
 3. Minimum Design Compressive Strength, f'_c (ASTM C 39): 4500 psi at 28 days (provide applicable data to substantiate the chosen required f'_{cr})
 4. Maximum Water-Cementitious Materials Ratio: 0.45
 5. Air Content at Point of Placement (ASTM C 173): 3 percent max
 6. Maximum Allowable Slump at Point of Placement (ASTM C 143): 4" min, 6" max
 - a. Exception: see requirements for addition of high range water reducer for concrete to be pumped into place.
- D. Exterior Exposed Concrete: Proportion structural normal-weight concrete as follows:
1. Nominal Maximum Size Coarse Aggregate: 3/4-inches.
 2. Minimum Design Compressive Strength, f'_c (ASTM C 39): 4000 psi at 28 days (provide applicable data to substantiate the chosen required f'_{cr})
 3. Maximum Water-Cementitious Materials Ratio: 0.45
 4. Air Content at Point of Placement (ASTM C 173): 6 percent +/- 1.5%
 5. Maximum Allowable Slump at Point of Placement (ASTM C 143): 4" min, 6" max
 - a. Exception: see requirements for addition of high range water reducer for concrete to be pumped into place.
- E. Interior Walls and Piers: Proportion structural normal-weight concrete as follows:
1. Nominal Maximum Size Coarse Aggregate: 3/4-inches.
 2. Minimum Design Compressive Strength, f'_c (ASTM C 39): 5000 psi at 28 days (provide applicable data to substantiate the chosen required f'_{cr})
 3. Maximum Water-Cementitious Materials Ratio: 0.45
 4. Air Content at Point of Placement (ASTM C 173): 3 percent max
 5. Maximum Allowable Slump at Point of Placement (ASTM C 143): 6" min, 8" max

- D. Concrete delivered to the project with slump greater than the maximum specified shall be rejected. Slumps that are less than the specified may be increased by adding water to the mix to bring the mix to the specified slump, provided the following conditions are met:
1. The specified water to cementitious materials ratio is not exceeded.
 2. The batch ticket indicates the amount of water withheld from the mix so that the design water-cement ratio is not exceeded.
 3. No high-range water reducing admixtures have been added at the job-site.
 4. Any water that is added to mix is done in the presence of the Engineer or the owner's testing agent.
 5. The amount of water added is documented and provided to the architect.
 6. The amount of water added does not exceed 3 gallons of water per yard of concrete.
 7. Slump and air content tests are made after the water is added.
 8. Written approval is provided by the concrete supplier.
- E. Ice, if used, shall be potable, subject to the same requirements of water and accurately measured for addition into the mixer within the tolerances of ASTM C 94.
- F. Water shall not be added to structural concrete at the jobsite unless permitted by the Engineer.
- G. Maintain equipment in proper operating condition, with drums cleaned before charging of each batch. Wash water shall be fully discharged prior to beginning a new batch unless permitted by the Engineer and optional tests per ASTM C 94 are performed at a frequency of at least once per week. Schedule delivery of trucks in order to prevent delay of placing after mixing.
- H. Maximum concrete temperature at point of placement is 90 °F or 3 °F greater than that used in design unless otherwise permitted.

PART 3 - EXECUTION

3.1 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. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. 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. Install dovetail anchor slots in concrete structures as indicated.
 4. Do not embed any foreign items in concrete. Do not embed aluminum unless indicated. Do not embed conduit unless indicated.

3.2 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.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Except where indicated to be unbonded, roughen surfaces of hardened concrete at all vertical construction joints. Clean surface of laitance, coatings, loose particles, and foreign matter to expose aggregate.
 - 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete. Provide keyways in all construction joints in footings in walls and at junctions of walls and footings.
 - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. 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 shown and no more than 36 times the wall thickness. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 7. At joints between foundation systems and walls, and elsewhere, unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete. Use an approved bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces in accordance with manufacturers requirements only if directed or indicated.
- C. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.3 PREPARATION OF EQUIPMENT AND PREPARATION OF PLACE OF DEPOSIT:

- A. Before placing concrete, all equipment for mixing and transporting and placing concrete shall be cleaned, all debris and ice removed from spaces to be occupied by the concrete, forms thoroughly cleaned of soil, ice, or other coatings which will prevent proper bond, reinforcement shall be securely tied in place and expansion joint material, anchors, and other embedded items shall be securely positioned.
- B. Semi porous subgrade shall be sealed in an approved manner.
- C. Hardened concrete and foreign materials shall be removed from the conveying equipment. All equipment shall be checked for potential areas of contamination to the concrete during placement from abrasion or breaches in liquid conduits.
- D. Before placing concrete, the formwork installation, reinforcing steel, and items to be embedded or cast in must be complete. Notify other crafts involved in ample time to permit the

installation of their work; cooperate with other trades in setting such work, as required. Notify Engineer upon completion of installation of all reinforcing in ample time to permit inspection of the work.

- E. At slabs on grade, restore any damaged subgrade areas to specified density immediately prior to installation of slab subbase. Lab verify specified compaction. Install underslab membrane over compacted stone. Provide another layer of membrane over any punctures or tears, lapping sealing edges as prescribed for sheet joints. Turn up membrane at edges of all slabs, unless otherwise detailed.
- F. Soil at bottom of all foundation systems shall be inspected by a testing laboratory. Place concrete immediately after approval of foundation excavations and installation of reinforcing, etc.

3.4 CONCRETE PLACEMENT:

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Engineer.
- C. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practical by methods which will prevent separation or loss of ingredients and in a manner which will assure that quality concrete is installed.
- D. Conveying equipment shall be of size and design to insure a continuous flow of concrete at the delivery end.
- E. Use approved tremies for vertical placements unless otherwise permitted. Do not allow concrete to freefall distances that may cause segregation.
- F. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.
- G. Do not use concrete which has become non plastic and unworkable or does not meet the required quality control limits, or which has become contaminated by foreign material. Do not use concrete that is non-uniform or contains lumps or balled material. Remove rejected concrete from the project site and dispose of in an acceptable location.
- H. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit in a manner to avoid inclined construction joints. Deposit concrete as nearly as possible to its final location to avoid segregation. Do not subject concrete to any procedure that will cause segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301. Consolidate in a manner to avoid segregation.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have set. 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.
 4. For mass concrete, as indicated by the Engineer, deposit concrete in forms in horizontal layers not deeper than 24".
- I. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- J. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
- K. Bring surface of slabs to the correct elevations with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps and hollows. Do not sprinkle water on the plastic surface. Do not work bleed water or sprinkled water into the surface. Do not disturb the surface prior to beginning the finish operation.
- L. Pumped concrete shall be appropriately proportioned so that concrete properties do not drastically change through the pump. The pumping operations shall not create segregation or otherwise negatively affect the concrete. Comply with the following:
1. Concrete pumps shall be positive piston type pumps. No squeeze pumps will be permitted.
 2. Concrete contaminated with pumping aids shall be discarded. Priming mixtures not in conformance with these specifications shall be discarded.
 3. Fresh concrete testing shall be conducted at the point of placement when the concrete is pumped.
 4. The submitted concrete mix design shall indicate that the mix is designed to be pumped. Once mix designs are approved, changes in the mix to accommodate pumping shall be prohibited unless new mix designs are submitted for approval.
- M. Surface moisture evaporation rate of exposed concrete surfaces during placement and prior to implementation of moist curing measures shall be maintained below levels described herein. Use equipment and determine evaporation rate of exposed concrete surfaces in accordance with ACI 305.1.

3.5 COLD WEATHER PLACEMENT:

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) 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 mixture designs.
 4. Do not place concrete when temperature is 40°F and falling, and when freezing weather is predicted within 24 hours unless protective measures are in place to provide adequate curing environment as outlined below
 5. High early strength (Type III) cement shall not be used.
- B. Thaw subgrades to six inches prior to placement. Demonstrate that subgrade is thawed with calibrated thermometer. All materials in contact with fresh concrete shall be above freezing at the time of placement unless otherwise permitted.
- C. In addition to laboratory cured test specimens, additional concrete test specimens shall be cured under field conditions as required and directed by the Engineer to check the adequacy of curing and protection of the concrete.
- D. Adequate equipment shall be provided for heating the concrete material and protecting the concrete during the cold weather length of protection shall be that time specified for curing. Maintain a minimum placement temperature and protection temperature surrounding the concrete during the entire curing period as specified in ACI 306.1. Record temperature once every 6 hours to demonstrate compliance.
- E. Slabs and other members are to be covered with insulated blankets or other suitable protection method per ACI 308.1. Supplement with external heating as required. Provide tented, heated areas surrounding concrete walls. Heaters which exhaust gases that contain carbons are not allowed except that indirect-fired heaters (that exhaust outside the enclosure) shall be permitted. Ensure that heat is spread evenly. Do not overheat individual areas or create excessive thermal gradients.

3.6 HOT WEATHER PLACEMENT:

- A. Hot-Weather Placement: Comply with ACI 301 and protect all concrete work from physical damage or reduced strength which could be caused by high ambient temperature, solar radiation, low humidity, or wind in compliance.
1. Maintain concrete temperature below 80 °F at time of placement unless otherwise permitted. Chilled mixing water or chipped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas. Keep forms and areas in contact with concrete continuously moist during curing.
- B. Cool reinforcing by wetting sufficiently so that the steel temperature will not exceed the ambient air temperature immediately before placing concrete. Use an approved admixture designed to retard the rate of set as necessary. Admixtures shall be tested in the design mix prior to use. Admixtures shall not contain any chlorides.
- C. Prompt curing shall be exercised. The use of evaporation retarders is prohibited unless otherwise permitted by the Engineer. Fogging used prior to application of final moist curing measures shall be done with an atomizing fogger; all exposed surfaces must be continuously fogged and surfaces must not be allowed to dry.
- D. The concrete supplier shall make provision for cooling concrete materials as necessary to meet specifications. Aggregates shall be uniformly moistened in stockpiles.

3.7 MISCELLANEOUS CONCRETE ITEMS:

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. 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 interior 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.
- C. Equipment Bases and Foundations: Provide machine and equipment bases as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.
- E. Concrete in earth: Where trench excavation is used, and where sides of excavations are cut neatly in good, firm soil, side-forms may be omitted.

3.8 FINISHING FORMED SURFACES:

- A. Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed class B limits for formed-surface irregularities.
 1. Apply to concrete surfaces only where not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and

defects. Remove fins and other projections that exceed class A limits on formed-surface irregularities.

1. Apply to concrete surfaces to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, painting or other similar system.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where concrete surface is exposed to public view:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces, perform necessary patching and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS:

- A. General: Use industry accepted techniques for screeding, restraightening and finishing operations to comply with the requirements of these ACI 301 and these specifications. Guidance can be found in ACI 302.1R. Do not wet concrete surfaces. Do not overwork surfaces. Do not segregate concrete from overworking. Coordinate all concrete finishes with the Engineer and final finished surface manufacturer prior to implementation.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings and/or to receive mortar setting beds for bonded cementitious floor finish, as required by the manufacturer or as indicated.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Floating shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after the first floating, the plane of surfaces shall be checked with a left straight edge applied at not less than two different angles. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated to receive trowel finish and/or to be covered with fluid-applied or sheet waterproofing, built up ort membrane roofing, or sand bed terrazzo, or as indicated.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that

would telegraph through applied coatings or floor coverings and finish replaced areas to blend with adjacent concrete.

1. Apply a trowel finish to surfaces exposed to view, to be covered with resilient flooring, linoleum, carpet, ceramic or quarry tile set over cleavage membrane, paint or another thin-film finish coating system, as required by the manufacturer, or as indicated.
 2. For floor installations greater than 10,000 ft², finish surfaces to the following tolerances, according to ACI 117 and ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface except as noted herein:
 - a. Specified overall flatness FF (SOF)F and levelness FL (SOF)L with minimum values equal to 2/3 of the specified values, required for application of the specific coating or overlay to be coordinated with the specific trade.
 - b. Moderately Flat as described in ACI 117 for exposed areas with minimum values equal to 2/3 of the specified values.
 - c. Contractor shall be responsible for meeting or exceeding flatness and levelness requirements. Any slabs which do not meet these requirements are subject to removal and replacement at the Owner's discretion at no additional cost to the Owner.
 3. For floor installations 10,000 ft² or less and incidental areas, finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm).
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thin-set method or where indicated. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances and methods for trowel finished floor surfaces.
- F. Broom Finish: Apply a non-slip broom finish as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- G. Slip-Resistive Finish: Apply Slip-Resistive Finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Before final floating, apply slip-resistive aggregate or aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions as indicated or directed and as follows:
1. Uniformly spread as indicated and not less than 25 lb/100 sq. ft. of dampened slip-resistive aggregate granules over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
 2. After broadcasting and tamping, apply float finish.
 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate granules.
 4. Curing: Wet cure for a period of seven days, minimum. Refer to other sections of specs.
- H. Control Joints: Saw-cut slabs as soon as possible after finishing using a saw blade that has a triangular arbor configuration to reduce edge raveling or dislodging aggregates at the following

spacing to minimize slab curling and cracking. Refer to plans for control joint layout. Fill joints in accordance with Architectural drawings.

- I. The floor flatness and levelness should be tested within 8 hours after completion of the final troweling operation according to ASTM E1155 - 96(2008) Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers by an independent testing agency experienced with the testing procedure and possessing the necessary equipment.
 - 1. Flatness and Levelness Requirements:
 - 2. Specified Overall Value Minimum Local Value
 - a. FF Floor Flatness 25 20
 - b. FL Floor Levelness 17 15
- J. Finishing: Refer to the Architectural drawings and specifications for finishes. The finished concrete shall slab comply with the damage and stain prevention provisions specified in the diamond polishing concrete floors specification.

3.10 MISCELLANEOUS CONCRETE ITEMS:

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. 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 interior 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.
- C. Equipment Bases and Foundations: Provide machine and equipment bases as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.
- E. Concrete in earth: Where trench excavation is used, and where sides of excavations are cut neatly in good, firm soil, side-forms may be omitted.

3.11 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 and ACI 305.1 for hot-weather or high evaporation protection during curing.
- B. 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.

- C. Unformed Surfaces: Begin curing immediately (within 10 minutes) after finishing concrete or when the surface is firm enough to resist marring. Implement fogging between finishing and application of final moist curing if final moist curing is delayed or evaporative conditions exist. Do not allow concrete to dry at any period after placement and during the curing period. Cure unformed surfaces including floors and slabs, concrete floor toppings, and other surfaces. Carefully apply curing measures so that surfaces are not marred.
- D. Moist cure concrete according to ACI 308.1, unless otherwise permitted or required. Record daily high and low temperatures adjacent to the concrete. Standard curing shall be seven-day moist cure except as approved otherwise:
1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Clean absorptive cover, water saturated, and kept continuously wet. Cover shall be clean and premoistened with clean water for a period of at least 24 hours prior to placement, but shall be kept dry when not in use. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers. A moisture retaining cover (as described below), fogger, soaker hoses and/or sprinkler shall be used to maintain moist conditions. Method must be approved and demonstrated to provide continuously moist conditions. Practice cold and hot-weather concrete procedures per ACI 306.1, ACI 305.1 and ACI 301, as necessary. Water shall not be more than 20 °F cooler or warmer than the concrete. At slabs on grade prevent curing water from entering construction and control joints.
 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. Moisture-retaining cover is to be used with absorptive cover above, unless permitted by the Engineer.
 3. Curing and Sealing Compounds: Use of curing compounds is prohibited unless permitted by the Engineer and approved by coating or floor covering manufacturer and installer in writing if applicable. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 4. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, shocks, excessive vibration, excessive thermal gradients, and from change caused by subsequent construction operations. Sequence placements such that influence from loading of adjacent spans does not create excessive bendings stresses and cracking.

3.12 JOINT FILLING:

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling with semi-rigid sealants until concrete has aged at least six month(s), and preferably one year. Do not fill joints until construction traffic has permanently ceased.
 - 2. Defer joint filling with flexible sealants for 60 days or as late as possible prior to installing floor finishes.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 1 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.
- D. Install flexible joint filler at least 1/2 inches deep in saw-cut joints and full depth in formed joints. Tool surface to provide full contact of sealant on sides of joint.

3.13 ARCHITECTURAL AND EXPOSED CONCRETE

- A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
- B. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.
- C. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
- D. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
- E. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- F. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
- G. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

3.14 CONCRETE SURFACE REPAIRS:

- A. Complete repairs at defective areas as described herein unless otherwise directed. Inform Engineer of all patching and repairs. Submit material data sheets and procedures for repair for approval prior to implementing repairs.

- B. Defective Concrete: Repair and patch defective areas as directed by and with approval of the Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval. If repair is not acceptable to the Architect, remove and replace defective concrete. Replace stained concrete that cannot be cleaned.
- C. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing, or use compatible prepackaged material, as required or approved. Patching materials shall be compatible with adjacent concrete and meet strength and durability requirements of this specification. Bonding agents shall be as indicated in ACI 301 or as approved by the Engineer. Use materials appropriate for specific type of repair. If commercial bonding agents and/or pre-packaged materials are approved, bonding agent and repair must be applied in strict accordance with manufacturer's requirements. All repair materials are subject to approval by the Engineer and Architect.
- D. 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. Repairs and materials shall be per ACI 301 and shall be completed immediately upon form removal, except that minimum repair depth is 1 inch.
1. Patch test areas at inconspicuous locations to verify mixture and color match before proceeding with patching.
 2. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- E. Repairing Unformed Surfaces: Repair surfaces in accordance with ACI 301. Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions. Finish repaired areas to blend into adjacent concrete.
 2. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate or use approved compatible pre-packaged materials, as required. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 3. 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.

- F. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- G. Repair materials and installation not specified above may be used, subject to Engineer's approval.
- H. Fill in holes and openings left in concrete structures for the passage work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in place construction. Provide all other miscellaneous concrete filling shown or required to complete work.
- I. Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected as directed by the Engineer, at the Contractor's expense, without extension of time therefore. The Contractor shall also be responsible for the cost of corrections to any other work affected by, or resulting from, correction to the concrete work.

3.15 TESTING AND FIELD QUALITY ASSURANCE:

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- D. Concrete Tests: 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 one composite sample for each day's placement of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Cost for additional sets of lab or field cured compressive strength cylinders required by the contractor as back-up to demonstrate conformance or for form removal or other construction operations shall be incurred by the contractor.
11. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
12. Test results shall be reported in writing to Architect, concrete manufacturer, Engineer, 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.
13. 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.
14. 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. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
15. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- 16. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

3.17 WORKMANSHIP

- A. Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected as directed by the Engineer, at the Contractor's expense, without extension of time therefore. The Contractor shall also be responsible for the cost of corrections to any other work affected by, or resulting from, correction to the concrete work.

END OF SECTION 03 30 00

SECTION 03 45 00 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Architectural precast concrete cladding units.
 - 2. Insulated, architectural precast concrete units.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for installing connection anchors in concrete.
 - 2. Division 04 Section "Unit Masonry" for thin brick setting materials and installation after precast concrete panel production.
 - 3. Division 05 Section "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
 - 4. Division 05 Section "Metal Fabrications" for kickers and other miscellaneous steel shapes.
 - 5. Division 08 Section "Aluminum Windows" for windows set into architectural precast concrete units.
 - 6. Division 09 Section "Tiling" for ceramic tile setting materials and installation.

1.3 DEFINITION

- A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Architect.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
 - 1. Loads: As indicated on Drawing SG.1.
 - 2. Dead Loads: Account for weight of storefront window system at conditions where system[s] bears on precast panels.
 - 3. Wind Loads: As indicated on Drawing SG.1. Account for wind loads where connections are made to precast panels.

SECTION 04 20 00 - 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. Face brick.
3. Mortar and grout.
4. Concrete and masonry lintels
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Masonry-cell insulation.
10. Cavity-wall insulation.
11. Masonry cleaners

- B. Products Installed but not Furnished under This Section:

1. Precast concrete trim in unit masonry.
2. Steel lintels in unit masonry.
3. Steel shelf angles for supporting unit masonry.

- C. Related Sections:

1. Division 05 Section "Cold Formed Metal Framing" for structural studs and sheathing used in masonry veneer construction.
2. Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
3. Division 07 Section "Thermal Insulation" for insulation installed other than in masonry cavities
4. Division 07 Section "Nonbituminous Self-Adhering Sheet Vapor-Permeable Air Barrier (AIB)" for air/vapor barriers applied in masonry cavities.
5. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
6. Division 07 Section "Joint Sealants" for waterproof sealants applied to masonry construction.

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

1. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Division 05 Section "Structural Steel Framing."

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 WORK INCLUDED IN THIS SECTION

- A. Work of this section consists of furnishing, fabricating, delivering, and erecting structural steel complete as required by drawings.
- B. Material furnished under this section shall include, but not be limited to the following:
 - 1. Steel superstructure including column anchor bolts, column base plates, columns, beams, girders, bearing plates, connection plates, shear studs, angles, bracing, permanent field bolts, welding, and detail material required to complete the job.
 - 2. Cleaning, preparation, priming, and field touch-up painting is included.
 - 3. Anchors and other anchorage devices embedded in concrete and masonry as shown on the structural drawings and as specified herein.
 - 4. Grout for column base plates and beam bearing plates.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Adhesive Anchors (Section 03 25 00)
- B. Steel Decking (Section 05 31 00)

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Some products and execution are specified in this section by reference to published specifications or standards of the following (with respective abbreviations used):

American Institute of Steel Construction (AISC)
The American Society for Testing and Materials (ASTM)
American Welding Society (AWS)
Steel Structures Painting Council (SSPC)
 - 2. Standard References:
 - a. The current edition of the following references shall apply to work of this section. Suffixes indicating date of issue are omitted from reference numbers used in the text of this section.
 - b. Publications of AISC:
 - (1) "Code of Standard Practice for Steel Buildings and Bridges".

- (2) "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings", including "Commentary", and supplements thereto.
 - (3) "Specifications for Structural Joints using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (except high strength A490 bolts are to be tightened to a tension value of 28,000 pounds and A498 bolts to a tension value of 49,000 pounds in any connections other than bearing type connections.).
- c. Publications of ASTM: ASTM A6 - "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
 - d. Publications of AWS: AWS D1.1 - "Structural Welding Code".
3. Manufacturer's Specifications: Any material or operation specified by reference to published specification of a manufacturer shall comply with requirements of latest edition of standards listed herein. In case of conflict between reference specification and contract document, the contract documents shall govern.

B. Source Quality Control:

1. Materials and fabrication procedures shall be subject to inspection and tests in mill, shop, and at project. Test shall be conducted by a qualified inspection agency provided by Owner.
2. Such inspections and tests shall not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
3. Promptly remove and replace materials or fabricated components which do not comply with requirements of contract documents.
4. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated as AISC-Certified Erector, Category ACSE, CSE.

C. QUALIFICATIONS OF THE FABRICATOR: The Fabricator of all structural steel shall have the following qualifications:

1. The Fabricator shall have been in the steel fabrication business no less than 10 years and have successful prior experience as the principal structural steel fabricator on projects of similar design and complexity as this project.
2. The Fabricator shall submit upon request a list of at least three (3) projects which demonstrate sufficient prior experience. The list shall include project name, location, date, Owner's name, name and phone number of the Owner's Representative, and a description of the steel framing system.

3. The Fabricator shall have sufficient production capacity and quality control programs in place to meet the proposed project schedule with work which meets the requirements of the Contract Documents.
 4. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- D. Qualification for Welding Work:
1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
 2. At Contractor's expense, provide certification to the Engineer that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months prior to the start of work.
 3. If recertification of welders is required, retesting shall also be Contractor's responsibility.
 4. Welders shall be able to produce certification cards at jobsite on demand.
- E. Design Criteria for Members and Connections:
1. Details shown on drawings are generally typical. Similar details shall apply to similar conditions, unless indicated otherwise. Verify dimensions at the site without causing delay in work.
 2. Promptly notify Engineer whenever design of members and connections for any portion of the structure are not indicated clearly.
 3. Fabricator is to design any connections not specifically detailed on drawings. Submit design for Engineer's approval. Design shall be in accordance with latest AISC Specifications and the North Carolina State Building Code and shall support the design load. Connection designs shall include specifics including weld length, size, location, etc. and shall be clearly indicated on the shop drawings. Calculations for the design of connections shall be provided for standard connections for reference, for all atypical connections and at the request of the Engineer.

1.5 SUBMITTALS

A. LEED Submittals:

1. Product Data: For products having recycled content, documentation including percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data: For products being extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Include statement indicating cost for each product considered as a regional material.

B. Shop Drawings:

1. Submit shop drawings of all fabricated materials to be furnished and delivered to the site. Erection drawings to locate and identify members shall accompany shop drawings. Do not use copies of contract drawings to produce shop drawings.
2. Submit copies of each shop and erection drawing sheet of the shop drawings.
3. Show details and schedules for fabrication and shop assembly of members. Show details, schedules, procedures, and diagrams indicating sequence of erection. The sequence of erection must be coordinated with and take into consideration the event schedule of the facility as provided in the specifications.
4. Wherever possible, details and sections shown on shop drawings shall be identified by use of same marks used on contract drawings.
5. Show details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols; show size, length, and type of each weld.
6. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages to be installed by others.
7. Only complete shop drawings which are checked and stamped "Approved by Contractor" will be accepted for review.

C. Product Data and Manufacturer's Printed Installation Instructions: Submit (in triplicate) the following for review by Project Engineer:

1. Laboratory test reports or other data as required to show compliance with contract documents of the following:
 - a. Structural steel (each type), including certified copies of mill reports covering the chemical and physical properties for record only.
 - b. High-strength bolts (each type), including nuts and washers.
 - c. Unfinished bolts and nuts.
 - d. Welding electrodes
 - e. Grout for column base plates
2. Submit manufacturer's specifications and installation instructions of the following:
Shop paint for structural steel.
3. Indicate by transmittal form that a copy of each applicable instruction has been distributed to fabricators, installers, and erectors.

- D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel", for each welded joint whether prequalified or qualified for testing, including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand critical welds.
- E. Qualification Data: For qualified installer fabricator.
- F. Welding Certificates.
- G. Sustainable Design Submittals:
 - 1. Product Data for Sustainable Design Credit: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

1.6 DELIVERY, HANDLING, AND STORAGE

- A. Deliver materials to site at such intervals as to ensure uninterrupted progress of work.
- B. Store materials in an arrangement and manner that will permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from mud, corrosion, and deterioration.
- C. Protect steel members stored on the job site from extended periods of exposure that might result in corrosion or deterioration. Dunnage, skids, etc. are to be used in shipping, storage, etc. Members are not to be placed in direct contact with the ground or moisture during any phase of storing and handling.
- D. Store members on skids to prevent contact with the ground.
- E. Store and handle steel members to prevent distortions that would result in damage to the members. Nylon slings for handling are required.

1.7 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturer's recommendations to ensure that shop primers and topcoats are compatible with one another. Coordinate steel surfaces to receive spray on fireproofing with spray on fireproofing manufacturer.
- 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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 90 percent.
- B. Regional Materials: Products to be used in the creation of the concrete mixes for the project shall be extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. Provide a minimum of 20 percent of the products that qualify as Regional Materials.
- C. Rolled Steel Plates, Shapes, and Bars: W-shapes and WT-shapes, ASTM A992 or A572, $F_y=50$ ksi. All other ASTM A36, $F_y=36$ ksi.
- D. Rectangular and Square Cold-Formed Steel Tubing: ASTM A500, Grade B; $F_y = 46$ ksi.
- E. Round Cold-Formed Steel Tubing: ASTM A500, Grade C; $F_y = 46$ ksi.
- F. Steel Pipe: ASTM A53, Type E, Non Tested, Grade B; $F_y = 35$ ksi.
 - a. Weight Class: Standard, Extra Strong, Double-Extra strong as indicated in drawings.
 - b. Finish: Black except where indicated to be galvanized
- G. Anchor Bolts/rods: ASTM F1554, GR 55.
- H. High-Strength Threaded Fasteners: Heavy hexagon bolts, nuts, and hardened washers complying with ASTM A325 unless otherwise noted.
- I. Electrodes for Welding: Comply with AWS Code, ASTM A233-E70 Series electrodes.
- J. Unfinished Threaded Fasteners: ASTM A-307, Grade A, regular low carbon steel bolts and nuts.
- K. Headed Stud Type Shear Connectors: ASTM A-108 Grade 1015 or 1020, cold finished carbon steel with dimensions complying with AISC Specifications.
- L. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847, structural tubing
- M. Steel Castings: ASTM A 216, Grade WCB with supplementary requirement S11.
- N. Steel Forgings: ASTM A668

O. Shop Coating System:

Shop Primer:

1. All unexposed steel shall receive a SSPC Paint 25, Type II, zinc oxide, alkyd, linseed oil primer. All other exposed steel (Including Lintels): Hot dip galvanized or equivalent zinc-rich primer, if approved.
 2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 3. SSPC-SP 2, "Hand Tool Cleaning."
 4. SSPC-SP 3, "Power Tool Cleaning."
 3. Total dry film thickness shall be not less than 3.0 mils. Allow final coat to dry to thumbnail hardness before transporting. Paint within 10 hours of cleaning and before there is visible rust.
- P. Nonmetallic: Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.
- Q. Asphaltic type paint for application as noted herein (Field Painting, Section 3.03).

2.2 FABRICATION

A. Shop Fabrication and Assembly:

1. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
 1. Camber structural steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
2. Properly mark and match-mark materials for field assembly. Fabricate for delivery in sequence which will expedite erection and which will minimize field handling of materials.
3. Exposed Structural Steel: Members that are exposed to view and highly visible shall be designated on plan as AESS in accordance with AISC standards. AESS framing shall meet or exceed the requirements and tolerances set forth by AISC and shall have radiused edges and corners and shall have finished surfaces free of defects which would impair a smooth, uniform appearance in the completed structure. Where finishing is required, complete the assembly, including welding

of units, before start of finishing operations. Provide finish surfaces of members (exposed in final structure) free of markings, burrs, non-radiused copes, and other defects.

4. Members shall be free from twists, kinks, or open joints and shall be made that when assembled the parts shall come together without shimming.

B. Connections:

1. Weld or bolt shop connections, as indicated.
2. Bolt field connections, except where welded connections or other connections are indicated. Provide high-strength, threaded fasteners for all bolted connections.

C. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints" using ASTM A325 Bolts or A490, Type "N", unless otherwise noted on drawings. Provide high strength bolts for all connections except column anchor bolts. Tighten 3/4" diameter high strength bolts to 28,000 pounds tension in "slip critical" connections and braced frame connections. Bearing type connections shall be snug tight.

D. Welded Construction: Comply with AWS Code D1.1 for procedures, appearance, and quality of welds; and for methods used in correcting welding work.

1. Assemble and weld built-up sections by methods which will produce true alignment of axis without warp.
2. All surfaces of structural steel to which welds shall be applied shall be power tool cleaned for a minimum distance of two inches around the weld, removing all dust, oil, rust, or other substances which may inhibit weld fusion, leaving a clean, shiny, metal surface. Omit painting from surfaces to be welded.
3. Welds exposed to view in the completed structure shall be ground smooth.

E. Holes in Structural Steel:

1. Holes required for securing other work to structural steel framing will not be allowed.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
3. Under no circumstances shall holes or cuts be made in structural steel members in the field, unless specifically directed by the designer.

F. Measurements:

1. The dimensions and location of all members are indicated on the drawings, sections and details, all which are believed to be correctly shown; but the fabricator and Contractor shall verify by field measurements all dimensions and elevations

for both new and existing construction prior to beginning detailing or fabrication of the structural steel.

2. The Contractor shall field verify dimensions and elevations and shall notify the Engineer and steel fabricator of any discrepancies from the plan dimensions and elevations prior to continuing with work.
- G. Embedded Shapes: Steel angles, plates, and other steel shapes which are embedded in concrete in a exposed condition, including masonry lintels, shall be hot dip galvanized in accordance with ASTM A153 with a minimum coating weight of 1.50 oz./sq.ft.
- H. Stud Connectors and Anchor Studs:
1. All studs shall be end welded with automatically timed stud welding equipment in accordance with manufacturer's recommendations.
 2. When two or more stud welding guns are operated from the same power source, they shall be interlocked so that only one gun can be operated at a time, and so that the power source has fully recovered from making one weld before another weld is started.
 3. The structural member receiving the stud shall not be painted prior to welding.
 4. Surfaces to which studs are to be welded shall be free of rust, scale, or other injurious materials as required to obtain satisfactory welds.
 5. Surfaces shall be dry.
 6. Studs, after welding, shall be free from any defect or substance that would interfere with their intended function. If after welding visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained from a particular stud, stud is to be replaced. Studs at each end of each member shall be struck with a hammer and bent 15 degrees off perpendicular to the beam. Studs failing this test shall be replaced.

2.3 SHOP PAINTING

- A. General Requirements for Shop Painting:
1. Do not paint surfaces which will be field welded, concrete encased, fireproofed, galvanized or are part of "slip critical" bolted connections.
 2. Coordinate painting requirements with manufacturer of fireproofing material on all surfaces to receive fireproofing. Steel members to be fireproofed should not be primed or painted, unless otherwise noted by the fireproofing manufacturer.
 3. Paint all other surfaces.
- B. Surface Preparation:

1. After inspection, and before shop priming, clean steelwork to be painted. Remove loose rust, oil, grease, loose mill scale, and splatter, slag, flux deposits, etc.
2. Clean unexposed steel in accordance with SSPC Specification SP-2, "Hand Tool Cleaning". Clean exposed steel in compliance with SSPC- SP6, "Commercial Blast Cleaning". Provide radius on edges and corners of exposed steel.
3. All sharp and rough edges are to be ground round. Avoid oil deposits that would require solvent cleaning, blast and prime all contact surfaces before shop bolting or welding. Blast clean all shop bolting or welding. Blast clean all shop and field bolts and bolt heads. Painting equipment is to be kept clean. Avoid contamination of the coating system. Insure that entire surface receives at least the minimum coverage.

C. Painting:

1. Immediately after surface preparations, apply shop paint in accordance with manufacturer's printed instructions, and at a rate to provide a uniform dry-film thickness specified hereinbefore.
2. Use painting methods which will result in full coverage of joints, corners, edges, and all surfaces.

2.4 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
1. Galvanize lintels, shelf angles, steel members exposed to the exterior (such as, but not limited to, mechanical equipment supports or solar array frames) or to corrosive environments, as shown on the drawings, and all other steel members attached to structural-steel frame located in exterior walls.

2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, 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. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Erector shall examine areas and conditions under which structural steel shall be installed.
- B. Erector shall notify Engineer and Contractor (in writing) of conditions detrimental to proper and timely completion of the work.
- C. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to erector.

3.2 ERECTION

- A. Surveys: The Contractor shall use qualified personnel to lay out, locate and set correct elevations on all members. A registered surveyor is required for the layout of column anchor bolt settings. Field verification of all existing conditions shall be performed by the erector prior to installation of any work for comparison with the shop drawings, contract drawings and the existing conditions. Notify the Engineer immediately of any discrepancies that exist between the final locations and plan locations.
- B. Field Assembly:
 1. Set structural members accurately to lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Erection is to be in compliance with AISC, Code of Standard Practice for Steel buildings and Bridges, unless otherwise noted.
 2. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly.
 3. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of the structure within specified AISC tolerances.

4. Splice members only where shown or specified. No splice or other connection welded or otherwise shall be made without having been detailed on shop drawings or permitted in writing by the Engineer.
5. On exposed welded construction, remove erection bolts, fill holes and plug welds, and grind smooth at exposed surfaces.
6. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
7. No permanent bolting or welding shall be done until structure has been properly aligned and plumbed.
8. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts with approval of Engineer.
9. Unless specifically identified on the Drawings, standard connections shall be designed as snug tight connections. Fasteners shall be tightened in properly aligned holes. When slip critical joints or pretensioned bolts are required, tighten bolts to the minimum tension specified. Tightening shall be by the turn of the nut procedure or other approved method. Provide hardened washers under all elements to be turned.
10. Gas Cutting:
 - a. Do not use gas cutting torches in the field for correcting fabrication errors in structural framing.
 - b. Finish gas-cut sections equal to a sheared appearance when permitted. This includes cutting with saws, grinding and touch up painting, as required to remove any rough edges, burrs, or other stress risers.
11. The erector shall establish permanent bench marks as shown and as necessary for the accurate erection of the structural steel. Check elevations of concrete and masonry bearing surfaces. The erector shall report measurement or elevation discrepancies to the Contractor. Do not proceed with erection until discrepancies have been corrected or until adjustments to the structural steel work have been agreed upon by the Engineer.
12. Temporary Shoring and Bracing: Provide temporary shoring and bracing members as required, with connections of sufficient strength to support imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.
13. Anchor Bolts:
 - a. Furnish anchor bolts and other connectors required for securing structural steel to in-place work.

- b. Utilize templates and other devices as necessary for presetting bolts and other anchors to accurate locations.

14. Setting Bearing and Base Plates:

- a. Clean concrete and masonry bearing surfaces of bond- reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
- b. Set loose and attached base plates and bearing plates for structural members on wedges, or other adjustable devices where specified.
- c. Tighten the anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims; but if protruding, cut off flush with the edge of base or bearing plate prior to packing with mortar.
- d. Mix bedding mortar in strict accordance with the manufacturer's instructions.
- e. Pack or pour bedding mortar solidly around bearing surfaces and bases of plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and cure in strict compliance with manufacturer's instructions, or as otherwise required.

15. Field Connections:

- a. High-strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
- b. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

C. Touch-up Painting:

- 1. After erection of structural steel, all dirt, grease, film or any other stains shall be thoroughly cleaned from all surfaces. All areas where the shop coat of paint has

been scratched or damaged, all bolts and all welded areas shall be thoroughly cleaned and sanded to bare metal and painted, using the same type paint as was used for the shop coat.

2. The touch-up shall be applied to the top flanges of the structure prior to the installation of the metal roof deck.

3.3 FIELD PAINTING

1. Field paint below-grade surfaces and with asphalt type paint.
2. Field paint un-galvanized steel surfaces exposed in cavity behind masonry veneer with asphaltic type paint.
3. Field paint columns below finished floor elevation with asphaltic type paint.

3.4 FIELD QUALITY CONTROL

- A. The Owner will engage an independent testing agency or engineer to inspect high-strength bolted connections and welded connections, and to perform tests and prepare test reports. Contractor shall coordinate testing.
- B. Testing Program:
 1. Testing agency shall conduct and interpret tests as subsequently required herein, shall state in each report whether test specimens comply with requirements, and shall specifically state any deviations. Visual inspection of typical bearing type bolted shear connections and single-pass fillet welds shall be performed by the engineer.
 2. Shop and Field Welding: Inspect and test during fabrication and erection of structural steel assemblies in accordance with AWS D1.1 Structural Welding Code and as follows:
 - a. Conduct inspections and tests as required. Record types and locations of all defects found in the work. Record work required and performed to correct deficiencies.
 - b. Perform visual inspection of all welds.
 - c. 100% of full penetration and partial penetration welds shall be subjected to and satisfy the requirements of ultrasonic testing in accordance with ASTM E 164, unless otherwise specified.
 - d. 10% of fillet welds shall be subjected to and satisfy the minimum requirements of magnetic particle testing and weld gauge measurement, unless otherwise specified. The welds shall be selected by the Engineer of Record and the testing agency.

- e. Perform additional tests to reconfirm any noncompliance of the original work and as may be necessary to show compliance of corrected work. Retesting of non-compliant work will be at contractor's expense.
3. Bolted Connections: The laboratory will test with a torque wrench high strength bolts for proper tightening in accordance with AISC, as follows:
- a. Visually inspect all bolts and bolted connections.
 - b. Test 10% of all bolts to be tensioned for proper tightening. All bolts that fail shall be corrected and retested.
 - c. Perform additional tests to reconfirm any non-compliance of the original work and as may be necessary to shown compliance of corrected work. Retesting of non-compliant work will be at contractor's expense.
 - d. Correct conditions in the Work that test reports and inspections do not comply with the Contract Documents.

C. Cooperation of Contractor with Testing Agency:

- 1. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished as required by Designer.
- 2. Contractor shall assist testing laboratory by providing access to all bolts and welds to be inspected.

3.5 CORRECTION OF WORK

- A. Correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to not be in compliance with requirements and at no additional expense to Owner.
- B. Additional testing as required for inspection of corrected work shall be at Contractor's expense.

END OF SECTION 05 12 00

SECTION 05 12 13 - ARCHITECTURALLY EXPOSED 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. Architecturally exposed structural-steel (AESS).
- 2. Requirements in Division 05 Section "Structural Steel Framing" also apply to AESS.

- B. Related Requirements:

- 1. Division 05 Section "Structural Steel Framing" for additional requirements applicable to AESS.
- 2. Division 05 Section "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
- 3. Division 09 Sections "Exterior Painting" and "Interior Painting" for surface preparation and priming requirements.

1.3 DEFINITIONS

- A. AESS: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.
- B. Category AESS 1: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 1 and may be designated AESS 1 or Category AESS 1 in the Contract Documents.
- C. Category AESS 2: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 2 and is designated as AESS 2 or Category AESS 2 in the Contract Documents.
- D. Category AESS 3: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 3 and is designated as AESS 3 or Category AESS 3 in the Contract Documents.
- E. Category AESS 4: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 4 and is designated as AESS 4 or Category AESS 4 in the Contract Documents.
- F. Category AESS C: Structural steel with custom characteristics that is categorized by ANSI/AISC 303, Section 10, as AESS C and is designated as AESS C or Category AESS C in the Contract Documents.

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof deck
 - 2. Acoustical cellular roof deck
 - 3. Composite floor deck
 - 4. Accessories including fasteners, closures, sump pans and pourstops
- B. Related Sections include the following:
 - 1. Section 032500 "Adhesive Anchors"
 - 2. Section 033000 "Cast-in-Place Concrete"
 - 3. Section 051200 "Structural Steel Framing".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, pans, cut deck openings and associated reinforcement, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of steel deck, signed by product manufacturer.
- B. Initial Certification Letter from Contractor's Professional Engineer: The Contractor's Professional Engineer shall submit a certification letter to the Architect and Owner prior to the submission of the Shop Drawings for the metal deck. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this certification letter. The certification letter shall include the following:
 - 1. Signature and seal of the registered Professional Engineer (registered in the State, Commonwealth or District in which the project is located).

2. Statement that all metal deck shop drawings (including all connections, components, openings, spans and capacities) have been prepared in accordance with the Contract Document requirements and under the direction of the Professional Engineer.
 3. Statement that the Professional Engineer's signature and seal shall appear on all metal deck shop drawings (including all connections, components, openings, spans and capacities).
- C. Welding certificates.
- D. Qualification Data:
1. Provide evidence that the structural steel fabricator has a minimum of five (5) years of experience in designing, detailing and fabricating projects constructed in the USA.
 2. Provide evidence that the structural steel erector has a minimum of five (5) years of experience in the installation of structural steel for similar projects constructed in the USA.
- E. Field quality-control test and inspection reports.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
1. Powder-actuated mechanical fasteners
 2. Acoustical roof deck
- G. Research/Evaluation Reports: For steel deck.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
- B. Submit letter certifying that metal deck meets UL design certification number for fire ratings.
- C. 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."
- D. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings. Provide letter certifying that metal deck complies with FM Global requirements.

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.

1.7 COORDINATION

- A. Coordinate installation of sound-absorbing insulation strips in topside ribs of acoustical deck with roofing installation specified to ensure protection of insulation strips against damage from effects of weather and other causes.

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 E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Steel Deck Basis of Design: Vulcraft 3NPA-24
 - a. ASC Profiles, Inc.
 - b. Nucor Corp.; Vulcraft Division
 - c. Roof Deck, Inc.
 - d. United Steel Deck, Inc.
 - e. Verco Manufacturing Co.

2.3 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
 1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 minimum zinc coating.
 2. Galvanized and Shop-Primed Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 minimum, G90 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

3. Roof Deck Types
 - a. 1 ½ inch galvanized metal roof deck, 20 gauge, Type B.
 - b. 3 inch galvanized metal roof deck, 20 gauge, Type N.
4. Span Condition: Triple span or more.
5. Side Laps: #10 Screw fasteners as indicated or at 12" o/c max spacing.

2.4 ACOUSTICAL ROOF DECK

- A. Acoustical Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
 1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 minimum zinc coating.
 2. Galvanized and Shop-Primed Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 minimum, G90 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Gray top surface with white underside.

3. Acoustic Roof Deck Types

- a. 3 inch galvanized cellular acoustic metal roof deck with bottom plate, 20 gauge, Type N Cellular Acoustic.
4. Span Condition: Triple span or more.
5. Side Laps: #10 Screw fasteners as indicated or at 12" o/c max spacing
6. Acoustical Perforations: Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck.
7. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
 - a. Factory install sound-absorbing insulation into cells of cellular deck.
 - b. Installation of sound-absorbing insulation is specified.
8. Acoustical Performance: NRC 0.80, tested according to ASTM C423.

2.5 COMPOSITE FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 1. Galvanized Steel Sheet: ASTM A53, Structural Steel (SS), Grade 33 minimum, zinc coating.
 2. Galvanized and Shop-Primed Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33 minimum, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray or white baked-on, rust-inhibitive primer.
 3. Composite Floor Deck Types

- a. 2 inch galvanized composite metal deck, 20 gauge.
- 4. Span Condition: Triple span or more.

2.6 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws. All fasteners shall be driven flush and at 90 degrees to the metal deck support substrate.
- 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 20 gauge, 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 and minimum 16 gauge, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- H. Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- I. Recessed Sump Pans: Single-piece steel sheet, 14 gauge minimum, of same material and finish as deck, with 3-inch wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- J. Flat Sump Plate: Single-piece steel sheet, 14 gauge minimum, of same material and finish as deck. For drains, cut holes in the field.
- K. Bearing Plates, Angles: ASTM A36 steel.
- L. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.
- 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.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Take total responsibility to verify that the deck will support wet concrete loads and construction loads on the decking during and after installation. Provide, at no additional cost, any and all shoring required during concrete pouring and for other purposes consistent with concrete construction methods employed.
- 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.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- 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. Reinforce openings over 12 inches in size in accordance with structural framing details indicated on the drawings. Reinforce deck openings from 6 to 12 inches in size with 2x2x1/4 inch steel angles on each side of opening. Place angles perpendicular to flutes; extend minimum two flutes each side of opening and weld to deck.
- 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. Fasteners shall have equivalent or greater working capacity than 5/8 inch diameter puddle welds for floor decks and 3/4 inch diameter for roof decks.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, or screw fasteners and as follows.

1. Weld Diameter: 5/8 inch, nominal.
 2. Weld/Screw Spacing: Weld/screw edge and interior ribs of deck units with a minimum of two welds/screws per deck unit at each support. Space welds/screws 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, unless otherwise indicated on the Drawings.
 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 24 inches, and as follows:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
- 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.

3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
1. Weld Diameter: 5/8 inch, nominal.
 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds 12 inches on center.
 3. Weld Spacing: Space and locate welds as indicated.
 4. Weld Washers: Install weld washers at each weld location at decks 22 gage or less only.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 24 inches, and as follows:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
- 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.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- F. Pipes over 3 inches in diameter, mechanical units, or any point load in excess of 100 pounds shall not be supported by floor deck, regardless of concrete thickness above deck. Ductwork, ceiling and lights may be supported off floor deck provided the attachment is designed and supplied by the respective contractor.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements. Contractor shall be responsible for errors in fabrication and/or proper fitting of members shown on shop drawings.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- F. Replace units damaged during construction activity.

3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 09 Section.
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 09 Section .
- D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.
- E. Damaged and rough or unsightly work will be rejected by the Architect.

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Exterior load-bearing wall framing
2. Interior load-bearing wall framing
3. Exterior non-load-bearing wall framing
4. Floor joist framing
5. Roof trusses
6. Roof rafter framing
7. Ceiling joist framing

- B. Related Sections include the following:

1. Division 04 Section "Unit Masonry"
2. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections
3. Division 07 Section "Thermal Insulation"
4. Division 07 Section "Water Damage Class PB Exterior Insulation and Finish System (EIFS)"
5. Division 07 Section "Metal Wall Panels"
6. Division 07 Section "Joint Sealants"
7. Division 09 Section "Gypsum Board Systems" for interior non-load-bearing, metal-stud-framed assemblies

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

- B. Shop Drawings: Provide shop drawings prepared by the cold-formed metal manufacturer.

1. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing, fabrication, fastening and anchorage details, including mechanical fasteners.
2. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Submit signed and sealed Shop Drawings in accordance with Division 01 Section "Submittal Procedures".

SECTION 05 50 00 - 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. This Section includes the following:

1. Steel framing and supports for ceiling-hung toilet compartments
2. Steel framing and supports for overhead doors.
3. Steel framing and supports for countertops.
4. Steel tube reinforcement for low partitions.
5. Steel framing and supports for mechanical and electrical equipment
6. Steel framing and supports for applications where framing and supports are not specified in other Sections
7. Slotted channel framing.
8. Shelf angles
9. Structural-steel door frames
10. Miscellaneous steel trim
11. Metal ladders
12. Ladder safety devices.
13. Metal ships' ladders.
14. Pipe guards
15. Metal downspout covers

- B. Products furnished, but not installed, under this Section:

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.

- C. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry
3. Division 05 Section "Structural Steel Framing"
4. Division 05 Section "Metal Stairs and Railings"
5. Division 05 Section "Decorative Metal"
6. Division 09 sections "Interior Painting" and "Exterior Painting" for primers used on metal fabrications.
7. Division 32 Section "Plants" for tree grates.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Fasteners.
 - 2. Shop applied primer and paint products.
 - 3. Shrinkage-resisting grout.
 - 4. Slotted channel framing.
 - 5. Manufactured metal ladders.
 - 6. Ladder safety devices.
 - 7. Alternating tread devices.
 - 8. Metal ships' ladders.
 - 9. Metal bollards.

- B. Shop Drawings: Show fabrication and installation details for all metal fabrications. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. Steel framing and supports for ceiling-hung toilet compartments.
 - 2. Steel framing and supports for operable partitions.
 - 3. Steel framing and supports for overhead doors.
 - 4. Steel framing and supports for countertops.
 - 5. Steel reinforcement for low partitions.
 - 6. Steel framing and supports for mechanical and electrical equipment.
 - 7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 8. Shelf angles.
 - 9. Metal ladders.
 - 10. Ladder safety devices.
 - 11. Metal ships' ladders.
 - 12. Structural-steel door frames.
 - 13. Miscellaneous steel trim.
 - 14. Loose steel lintels.
 - 15. Provide templates for anchors and bolts specified for installation under other Sections.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

- B. Mill Certificates: Signed by manufacturers of stainless-steel sheet 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.

- E. Research Reports: For post-installed anchors.

- F. Design Data for Delegated Design Elements: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract

Documents, prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, calculations, and ladder and fall protection design data. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as "Not Reviewed"

- G. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:
1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
 2. Statement that the Professional Engineer is fully experienced in the type of design being performed.
 3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
 4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
 5. Statement that the Professional Engineer will submit an additional signed and sealed letter at the completion of work related to this section stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.

1.5 RECORD SUBMITTALS

- A. Final Certification Letter from Delegated-Design Professional: After construction of the delegated design element is complete, submit a signed and sealed Certification Letter from the responsible design professional stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel"
 2. AWS D1.2, "Structural Welding Code--Aluminum"
 3. AWS D1.3, "Structural Welding Code--Sheet Steel"
 4. AWS D1.6, "Structural Welding Code--Stainless Steel"
- B. Ladder Safety Systems Certification: Provide reports, certifications and approvals to Owner.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
- B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct the testing indicated.

1.8 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 anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design pipe railings, and ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - 2. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
- C. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation 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.

- D. Unless member sizes are shown on the structural drawings, all elements shall be considered delegated-design elements. All member sizes shown on the architectural drawings are minimum sizes that are required to be designed by the contractor's qualified professional engineer licensed in the project state.

2.2 METALS, GENERAL

- 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.

2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304.
- C. Stainless-Steel Bars and Shapes: ASTM A276, Type 304.
- D. Steel Tubing: ASTM A500, cold-formed steel tubing.
- E. Steel Pipe: ASTM A53/A53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- F. Slotted Channel Framing ("Unistrut"): Cold-formed metal channels with continuous slot complying with MFMA-3.
 1. Size of Channels: As indicated or required.
 2. Material: Galvanized steel complying with ASTM A653/A653M, Grade 33 (Grade 230), with G90 (Z275) coating; 12G 0.108-inch (2.8-mm) nominal thickness.
 3. Material: Steel complying with ASTM A1008/A1008M, Grade 33 (Grade 230); 12G 0.0966-inch (2.5-mm) minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
- G. Cast Iron: ASTM A48/A48M, Class 30, unless another class is indicated.

2.4 NONFERROUS METALS

- A. Aluminum Plate and Sheet: ASTM B209 (ASTM B209M), Alloy 6061-T6
- B. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6
- C. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6
- D. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F

2.5 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, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Low Emitting Materials:
 - 1. Products listed shall have a minimum VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - a. Architectural Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
- C. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- E. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless otherwise indicated.

2.7 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 true to line and level 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 where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be 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.

2.8 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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Fabricate supports for coiling doors, ceiling-hung toilet compartments, glazed openings head stiffening, and masonry partition stiffening from continuous structural steel members of sizes indicated with attached bearing plates, anchors, and braces as indicated, with holes where indicated on Shop Drawings of individual products.
- D. Galvanize miscellaneous framing and supports where indicated.
- E. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.9 LOOSE LINTELS

- A. Fabricate loose lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations 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.
- D. Prime loose steel lintels located in exterior walls with zinc rich primer.

2.10 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 shelf angles located in exterior walls.
- D. Prime shelf angles located in exterior walls with zinc-rich primer.
- E.

2.11 INDUSTRIAL PIPE RAILINGS

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
1. Configuration:
 - a. Handrail: Schedule 40 Pipe with an outside diameter not less than **1.32 inches (33 mm)**.
 - b. Top, Bottom and Intermediate Guardrails and Posts: Schedule 40 Pipe with an outside diameter not less than **1.9 inches (48 mm)**. Space intermediate rails not more than **21 inches (533 mm)** clear between.
 - c. These pipe railings shall be included only where noted on the drawings and are not to be used in lieu of decorative rails or metal stair rails specified in other sections.

2.12 METAL LADDERS

- A. General:
1. Comply with ANSI A14.3.
- B. Steel Ladders:
1. Space siderails **18 inches (457 mm)** apart unless otherwise **indicated**.
 2. Siderails: Continuous, **3/8-by-2-1/2-inch (9.5-by-64-mm)** steel flat bars, with eased edges
 3. Space siderails of elevator pit ladders **12 inches (300 mm)** apart.
 4. Support each ladder at top and bottom and not more than **48 inches (1220 mm)** o.c. with welded brackets, made from same metal as ladder
 5. Rungs: **3/4-inch- (19-mm-)** diameter steel bars.
 6. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 7. Provide nonslip surfaces on top of each rung by coating with abrasive material metallurgically bonded to rung.
 8. Galvanize exterior ladders and interior ladders, including brackets and fasteners.
 9. Prime interior ladders including brackets and fasteners, with zinc-rich primer, unless otherwise noted.
 10. 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.
 11. Support each ladder at top and bottom and not more than **60 inches (1500 mm)** o.c. with welded or bolted steel brackets.
 12. Every new fixed ladder installation that extends more than 24 feet above a lower level must be equipped with a personal fall arrest system or a ladder safety system.

2.13 LADDER FALL PROTECT

- A. General: Comply with requirements of ANSI Z359.16 and OSHA 1910.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. CAI Safety Systems.
2. FixFastUSA
3. Guardian Fall.
4. Simplified Safety.

C. Provide inspection approvals and certifications to Owner.

2.14 METAL SHIPS' LADDERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel stringers, pipe railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.

1. Fabricate ships' ladders, including railings from steel.
2. Fabricate treads from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than **3/4 inch (19 mm)** in least dimension.
3. Fabricate treads and platforms from rolled-steel floor plate.
4. Comply with applicable requirements in Division 05 Section "Metal Stairs" for railings.

B. Galvanize exterior steel ships' ladders and interior steel ships' ladders, including treads, railings, brackets, and fasteners.

C. Prime interior steel ships' ladders, where indicated, including treads, railings, brackets, and fasteners, with zinc-rich primer.

2.15 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime interior miscellaneous steel trim with zinc rich primer.

2.16 METAL DOWNSPOUT COVER

A. Source Limitations: Obtain downspout boots from single source from single manufacturer.

B. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: Vertical, to discharge into pipe.

- C. Prime cast-iron downspout boots with zinc-rich primer.

2.17 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.

2.18 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.

2.19 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A123/A123M, for galvanizing steel and iron products
 - 2. ASTM A153/A153M, for galvanizing steel and iron hardware
 - 3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.20 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Bright, Directional Satin Finish: No. 4..

- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.21 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

Finish in paragraph above is usually referred to as "mill finish." For service locations finish below is heavy-anodized finish for show locations.

- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

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 bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for ceiling hung toilet partitions and overhead doors securely to and rigidly brace from building structure.
- C. Anchor shelf angles securely to existing construction with expansion anchors, anchor bolts, or through bolts as indicated in approved shop drawings.
- 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 "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING INDUSTRIAL PIPE RAILINGS

- A. Installation, General
 - 1. Fit exposed connections together to form tight, hairline joints.

2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - a. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - b. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
 - c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
3. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - a. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

B. Railing Connections

1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Anchoring Posts

1. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Leave anchorage joint exposed with **1/8-inch (3-mm)** buildup, sloped away from post.
4. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - a. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
 - b. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
 - c. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

SECTION 05 51 00 - METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Channel stringer fabricated steel stairs with precast terrazzo treads.
2. Industrial-type stairs and ship stairs with steel grating treads.
3. Pipe railings attached to metal stairs.
4. Pipe railings at grandstands.

- B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section "Decorative Metal Railings" for ornamental metal railings.
3. Division 06 Section "Miscellaneous Rough Carpentry" for blocking for anchoring railings.
4. Division 09 Section "Non-Structural Metal Framing" for blocking for anchoring railings and for gypsum drywall products applied to stairs.
5. Division 09 Flooring Sections for flooring materials installed on metal stairs.
6. Division 10 Section "Wire Mesh Partitions" for wire mesh security partitions and doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For metal stairs and the following:

1. Prefilled metal-pan stair treads
2. Precast terrazzo treads
3. Woven-wire mesh.
4. Handrail wall brackets
5. Nonslip aggregates and nonslip-aggregate finishes
6. Shop primer products
7. Paint products
8. Grout.

- B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Provide templates for anchors and bolts specified for installation under other Sections.

SECTION 05 70 00 - DECORATIVE METAL

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. Decorative Aluminum Metal Sheet

1.3 COORDINATION

- A. Coordinate installation of anchorages for decorative metal items. 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 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for decorative metal.
 - 1. Include plans, elevations, component details, and attachment details.
 - 2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
- C. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.
- D. Samples for Initial Selection: For products involving selection of color, texture, or design including mechanical finishes.
- E. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of linear shapes

SECTION 05 73 00 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Stainless-steel decorative railings
 - 2. Illuminated decorative railings
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings
 - 2. Division 06 Section "Interior Finish Carpentry" for wood railings not specified herein.
 - 3. Division 09 Section "Gypsum Board Systems" for metal backing for anchoring railings
 - 4. Division 26 Sections for electrical service and connections for illuminated railings

1.3 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

1.4 COORDINATION AND SCHEDULING

- 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.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not meet structural performance requirements.

1.5 PREINSTALLATION MEETINGS

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

SECTION 05 75 00 - DECORATIVE FORMED METAL

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 base.

- B. Related Requirements:

- 1. Division 05 Section "Decorative Metal" for decorative items made primarily from plate, bars, extrusions, tubes, castings, and other forms of metal, but which may include sheet metal components.

1.3 COORDINATION

- A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.
- B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for decorative formed metal.
 - 1. Include plans, elevations, component details, and attachment details.

SECTION 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. Rooftop equipment bases and support curbs.
 2. Wood blocking, cants, and nailers.
 3. Wood furring.
 4. Wood sleepers.
 5. Plywood backing panels.
- B. Related Requirements:
 1. Division 06 Section "Sheathing" for sheathing, subflooring and underlayment.
 2. Division 06 Sections "Interior Finish Carpentry" and "Architectural Cabinets" for nonstructural carpentry items exposed to view and not specified in another Section.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal 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.

SECTION 06 16 00 – SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Wall sheathing.
2. Parapet sheathing.
3. Sheathing joint and penetration treatment.

- B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Division 07 Section "Vapor Permeable Barrier (AIB)" for water-resistive barrier applied over wall sheathing and testing requirements.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
 4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

SECTION 06 42 00 - ARCHITECTURAL MILLWORK

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. Architectural wood and wood product millwork, including but not limited to custom millwork and decorative partitions.
2. Plastic laminate faced millwork
3. Solid surface material countertops
4. Millwork hardware and accessories
5. Wood shims and hanging strips for installing architectural millwork.
6. Shop finishing of architectural millwork.

- B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking concealed within other construction required for installing millwork.

1.3 DEFINITIONS

- A. MDF: Medium-density fiberboard.
- B. MDO Plywood: Plywood with a medium-density overlay on the face.

1.4 PREINSTALLATION MEETINGS

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including panel products, high pressure decorative laminates, countertop materials and adhesives, cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

SECTION 06 64 00 - PLASTIC PANELING

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. Section Includes:

1. Plastic sheet paneling.
2. Factory-laminated plastic sheet paneling.

- B. Related sections include the following:

1. Division 06 section "Miscellaneous Rough Carpentry" for wood furring for installing plastic paneling.
2. Division 10 section "Wall and Door Protection" for corner guards installed over plastic paneling.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

- B. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.4 INFORMATIONAL SUBMITTALS

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319. Panels shall be USDA accepted for incidental food contact.
 - 1. Basis of Design: Marlite FRP Panels.
 - 2. Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Crane Composites, Inc.
 - b. Nudo Products, Inc.
 - 3. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 Insert value or less.
 - b. Smoke-Developed Index: 450 or less.
 - 1. Nominal Thickness: Not less than **[0.075 inch (1.9 mm)] [0.09 inch (2.3 mm)] [0.12 inch (3.0 mm)]**.
 - 2. Surface Finish: **[Smooth] [Molded pebble texture] [Smooth surface with filled grooves at 4 inches (102 mm) o.c. to resemble tile] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]**.
 - 3. Color: **[White] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]**.

2.3 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
 - 1. Color: Match panels.
- B. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
- C. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
- D. Adhesive: As recommended by plastic paneling manufacturer.

- E. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
- B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- C. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- E. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.
 - 1. Mark plumb lines on substrate at trim accessory locations for accurate installation.
 - 2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive where recommended by the manufacturer, based on project conditions.
- C. Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
 - 1. Drill oversized fastener holes in panels and center fasteners in holes.
 - 2. Apply sealant to fastener holes before installing fasteners.

- D. Install trim accessories with adhesive. Do not fasten through panels.
- E. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.
- F. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- G. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- H. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 06 64 00

- D. Where dampproofing interior face of above-grade, exterior concrete and masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- D. Concrete Foundations: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
- E. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
- F. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
- G. Concrete Backup for Brick Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
- H. Masonry Backup for Brick Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
- I. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.5 CLEANING

- D. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION 07 11 13

- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform **2-1/2-inch- (64-mm-)** minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
 - 1. When ambient and substrate temperatures range between **25 and 40 deg F (minus 4 and plus 5 deg C)**, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than **60 deg F (16 deg C)**.
- D. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- E. Seal edges of sheets at terminations under metal counterflashings, ending in reglets or termination bars with mastic.
- F. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing/flashings materials.
- G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending **6 inches (150 mm)** beyond repaired areas in all directions.
- H. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- I. Do not cover waterproofing membrane until Owner's field quality control inspections are complete.
- J. Install protection board with butted joints over waterproofing membrane, with adhesive spots.

3.4 PREFABRICATED DRAINAGE COMPOSITE INSTALLATION

- C. Place and secure prefabricated drainage composite panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. Install prefabricated drainage composite over insulation protection board per detail on drawings, down onto footing. Wrap ends of PDC panels with additional geotextile to prevent soil from contaminating the cores. Lap panels 4 inches and snap dimples. Install geotextile continuously over laps.

3.5 FIELD QUALITY CONTROL

- C. Testing Agency: Owner will engage a qualified testing agency to perform tests, and to furnish reports to Architect.
- D. Testing agent will inspect substrate conditions; surface preparation; membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

SECTION 07 14 13 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

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. Hot Rubberized-asphalt waterproofing membrane system, fabric reinforced, including primers, flashings protection mat and tie-in/terminations for split slab.
2. Prefabricated Drainage System.
3. Insulation.

- B. Related Sections:

1. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
2. Division 07 Section "Exterior Expansion Joint Cover Assemblies" for foundation-wall expansion joints that interface with waterproofing and for plaza expansion-joint assemblies that interface with waterproofing.

1.3 PREINSTALLATION MEETINGS

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

1. Approximately 7 days in advance of installation of waterproofing, arrange a conference at the job site for the purpose of physically viewing all waterproofing locations, to review waterproofing requirements, including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs; coordination of these activities; and satisfying any conditions which might interfere with proper application.
2. Conference shall be attended by the Contractor, Waterproofing Subcontractor, the specific waterproofing foreman for the project, the representative for the manufacturer of waterproofing materials, the independent inspection firm, the concrete subcontractor and the Architect.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

SECTION 07 21 00 - 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. Foam-Plastic Board Insulation
2. Mineral-Wool Board Insulation
3. Glass-Fiber Batt/Blanket Insulation
4. Mineral-Wool Batt/Blanket Insulation
5. Spray Polyurethane Foam

- B. Related Sections:

1. Division 04 Section "Unit Masonry" for insulation and drainage board installed in masonry cavity wall construction.
2. Division 07 Section "Spray Polyurethane Foam Insulation" for the spray foam insulation system applied to exterior walls.
3. Division 07 Sections Air and Vapor Barriers (AVB) and/or Vapor-Permeable Barriers (AIB) for membranes installed as part of these systems.
4. Division 07 Sections "Roofing" and "Waterproofing" for insulation installed as part of roofing and waterproofing construction.
5. Division 07 Section "Fire-Stopping" for insulation installed as part of a fire-resistive penetration or perimeter joint system.
6. Division 09 Section "Gypsum Board Systems" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION (XPS)

- A. Products: Subject to compliance with requirements, provide one of the following:

SECTION 07 27 15 - NONBITUMINOUS SELF-ADHERING SHEET VAPOR-PERMEABLE AIR BARRIER (AIB)

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. Nonbituminous, self-adhering sheet, vapor-permeable, air barriers (AIB).
2. Materials, systems, accessory products and installation methods to bridge and seal the following air leakage pathways and gaps:
 - a. Transition of the air barrier to the roof membrane and roof vapor barrier.
 - b. Transition of the air barrier to the foundations and foundation waterproofing.
 - c. Transition of the air barrier to expansion joints.
 - d. Transition of the air barrier to openings and penetrations such as window wall frames, door frames, store front systems, curtain wall systems and the like.
 - e. Seals to piping, conduit, duct and similar penetrations through the air barrier.
 - f. Seals to masonry ties, screws, bolts and similar penetrations through the air barrier.
 - g. All other air leakage pathways through and adjacent to the air barrier.

B. Related Requirements:

1. Division 06 Section "Sheathing" for wall sheathings.
2. Division 07 Sections "Waterproofing" for waterproofing materials which will interface with the vapor permeable barrier.
3. Division 07 Section "Thermal Insulation" for insulation which is compatible with the vapor barrier and NFPA 285.
4. Division 07 Sections "Roof and Roofing" for roof membrane and roof vapor barrier materials which will interface with the vapor permeable barrier.
5. Division 07 Section "Sheet Metal Flashing and Trim" for flashing tie-in to wall system.
6. Division 07 Section "Joint Sealants" for sealants used in conjunction with the vapor permeable barrier.
7. Division 07 Section "Exterior Expansion Joint Covers" for expansion joints which will interface with the vapor permeable barrier.
8. Division 08 Section(s) "Aluminum-Framed Entrances and Storefronts" for assemblies which will interface with the vapor permeable barrier.

SECTION 07 41 13.16 - STANDING-SEAM METAL ROOF 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. Vertical rib standing seam metal roof panel.
2. Underlayments
3. Metal gutters, downspouts
4. Flashings, curbs and accessories
5. Thermal Insulation, Substrate and Cover Board and Vapor Barrier.
6. Snowguards

- B. Related Sections:

1. Division 07 Section "Soffit Panels" for metal panels used in horizontal soffit applications.

1.3 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, substrate boards, underlayment and accessories necessary for a complete weathertight roofing system.

1.4 PREINSTALLATION MEETINGS

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

1. Meet with Owner, Architect, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.

SECTION 07 42 00 - RAINSCREEN WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sintered stone ventilated rainscreen wall panels

B. Related Requirements:

1. Division 07 section "Thermally Broken Rainscreen Attachment System" for subframing supporting the work of this section.

1.2 DEFINITIONS

- A. Rainscreen: an exterior wall assembly where the siding material stands off from the moisture-resistant surface of an air/water barrier to create a capillary break and to allow drainage and evaporation
- B. Sintered Stone: material formed through heating a mineral matrix to form a solid mass

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's product specifications, standard details, test results, and general recommendations, as applicable to materials and finishes for each component and for total system assemblies.
- B. Shop Drawings: Show layouts of all wall surfaces, details of corner conditions, joints, system profiles, supports, anchorages, trim, flashings, closures, and special details.
- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of panel.
- D. Samples for Verification: Actual sample of finished products for each type of exposed finish.
 1. Size: Manufacturers' standard size.
- E. Delegated Design: Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Certify system meets wind load and structural loads required by Code in the jurisdiction of the project.

1.5 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. Product Test Reports: For each panel product, for tests performed by qualified testing agency.
 - 2. Research Reports: For rainscreen panels, from ICC-ES or other agency acceptable to Authorities Having Jurisdiction showing compliance with fire resistance performance criteria.
- B. Source Quality-Control Submittals:
 - 1. Source quality-control reports.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports.
- D. Delegated design engineer qualifications.
- E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panels in open-joint rainscreen system.
- B. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panels: Assembled panels with dimensions matching maximum width and height on the project to be trimmed to size in case of panel failure, equal to 10 percent of quantity installed, but no fewer than 4 units.
 - 2. Clips and Fasteners: Aluminum mounting clips and concealed shallow expansion anchors for attachment to panels, no fewer than 10 of each.
 - 3. Drill Bit: Cove-cutting bit used to prepare holes for shallow expansion anchors; provide 2.
- B. Schedule of maintenance material items.

1.8 QUALITY ASSURANCE

- A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in North Carolina and who is experienced in providing engineering services of the type indicated.

1.9 MOCKUPS

- A. Build mockups to set quality standards for fabrication and installation.
 1. Build mockup at Feature Wall.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's requirements for packaging, delivery, storage, and handling. Use stable, flat pallets that are at least the same dimension as the sheets. Deliver panels in undamaged condition.
- B. Exercise care in unloading, storing, and erecting wall system to prevent bending, twisting, and surface damage.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of wall system to be performed according to manufacturers written instructions and warranty requirements.
- B. Field Measurements: Verify field measurements prior to fabrication. Coordinate fabrication schedule with construction to delays due to fabrication and delivery.

1.12 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace panels that fail(s) in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including pull-out of concealed fasteners.
 - b. Faulty operation of leveling screws.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

- d. Cracking of panels at fastener points.
 - e. Cracking of panels at sintered seams.
2. Warranty Period: 25 year(s) from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Mounting System Performance: Designed by the manufacturer to withstand structural loading due to wind load and dead load of the panel.
- B. Seismic Performance: Installed rainscreen system to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
- 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.
- D. Fire Performance:
 - 1. ASTM E-136: Non-combustible
 - 2. ASTM E-119: No degradation

2.2 SINTERED STONE PANELS

- A. General: Provide sintered stone panels of monolithic composition and color with attached clips for concealed fastening to rainscreen supports.
- B. Basis of Design: Dekton Façade by Cosentino USA.
- C. Acceptable Manufacturers: Subject to compliance with the requirements of this section, provide products from one of the following:
 - 1. Cosentino USA; (281) 494-7277; www.cosentino.com.
 - 2. Lapitec S.p.a; www.lapitec.com.
 - 3. Neolith; www.neolith.com.
 - 4. Petrarch; <http://petrarchpanels.com>.
 - 5. Steni; www.steni.com.
- D. Thickness: 0.47 inch (12 mm)
- E. Obtain panels from single source.
- F. Finish: Manufacturer's standard matte finish
- G. Color: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

- A. Clips and rails: Provide extruded aluminum clips and rails of the same extrusion capable of nesting to create support for panels. Provide set screw on clips for field adjustment of panels to achieve level and plumb alignment.
- B. Anchors: For attachment of clips to back side of panel. Provide concealed shallow expansion anchor.

2.4 FABRICATION OF PANELS

- A. Shop Assembly: Prepare panel for and install concealed clips at back of panel using concealed shallow expansion anchor system.

2.5 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for requirements indicated for conditions affecting performance of the Work.
- B. Reject assembled panels that are damaged.
- C. Examine roughing-in for {Insert system name} piping to verify actual locations of piping connections before {equipment} {fixture} installation.
- D. Examine walls, for suitable conditions where panels will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation using method and materials recommended by the manufacturer for project conditions.

3.3 INSTALLATION

- A. Install panels and sub-frame system in accordance with manufacturer's guidelines and approved submittals.

- B. Install panels plumb and level and accurately spaced in accordance with manufacturer's recommendations and approved submittals and drawings.
- C. Anchor panels and sub-framing securely per engineering recommendations and in accordance with approved shop drawings to allow for necessary movement and structural support.
- D. Do not install panels or component parts which are observed to be defective or damaged including, but not limited to: warped, bowed, abraded, scratched, and broken members.
- E. Do not cut or trim component parts during installation in a manner that would damage the finish, decrease the strength, or result in visual imperfection or a failure in performance. Return component parts with require alteration to the shop for re-fabrication or replacement.
- F. Install corner profiles and trim with fasteners appropriate for use with adjoining construction as indicated on the Contract Drawings and as recommended by manufacturer.

3.4 ADJUSTING

- A. Remove masking and panel protection as soon as practical after installation.
- B. Adjust final panel installation so that all joints are true and even throughout the installation. Panels out of plane shall be adjusted with the surrounding panels to minimize any imperfection.
- C. Repair panels with minor damage. Remove and replace panels damaged beyond repair as a direct result of the panel installation.

3.5 CLEANING

- A. Clean finished surfaces as recommended by the manufacturer.

END OF SECTION 074200

SECTION 07 42 13.13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Concealed-fastener, lap-seam metal wall panels.

- B. Related Sections:

- 1. Division 05 Section "Cold-Formed Metal Framing" for support framing, including girts, studs, and bracing.
 - 2. Division 07 Section "Soffit Panels" for metal panels used in horizontal soffit applications.
 - 3. Division 07 Section "Insulated-Core Metal Wall Backup Panel" for insulated core back-up panels with vapor barrier.
 - 4. Division 07 Section "Thermally-Broken Rainscreen Attachment System" for thermally broken sub-girt support system.
 - 5. Division 07 Section "Sheet Metal Flashing and Trim" for flashing and other sheet metal work that is not part of metal wall panel assemblies.

1.3 DEFINITION

- A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

1.4 PREINSTALLATION MEETINGS

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

- 1. Meet with Owner, Architect, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.

SECTION 07 42 19 – THERMALLY BROKEN RAIN SCREEN ATTACHMENT SYSTEM

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. Engineered, tested, thermally-broken, cold-formed metal rain screen framing assembly at exterior cavity walls.

- B. Related Requirements:

- 1. Division 03 Section “Cast in Place Concrete” for connections to concrete wall construction
- 2. Division 04 section “Adhered Stone Masonry Veneer” for support of stone veneer.
- 3. Division 05 Section "Cold-Formed Metal Framing" for support framing for sub-girt framing.
- 4. Division 07 Section Formed Metal Wall Panels for exterior wall panels applied to sub-girt support system.
- 5. Division 07 Section "Sheet Metal Flashing and Trim" for metal flashing components at openings and perimeter.

1.3 PREINSTALLATION MEETINGS

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

- 1. Meet with Owner, Architect, Owner, metal panel installer, structural support manufacturer's representative, structural-support installer, and installers whose work interfaces with or affects structural sub-girt installation, including installers of doors, windows, and louvers.
- 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- 3. Review methods and procedures related to panel and structural sub-girt installation, including manufacturer's written instructions.
- 4. Examine support conditions for compliance with requirements, including alignment between and attachment to cold-framed metal members.
- 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect structural sub-girt.
- 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.

SECTION 07 42 93 - 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. Division 07 Section "Formed Metal Wall Panels" for lap-seam metal wall panels.

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:

SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleaning substrate.
2. Adhered polyvinyl-chloride (PVC) roofing system.
3. Roof cover board.
4. Roof insulation.
5. Vapor barrier and primer
6. Roof substrate board
7. Roof walkway pads.
8. Flashing and sealing membrane to curbs, piles, termination, etc.
9. Installation of roof drains furnished under Division 22.
10. Installation of prefabricated curbs furnished under Division 23.
11. Inspection by membrane manufacturer.

B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Division 06 Section "Sheathing" for wood-based, structural-use roof deck panels.
3. Division 07 Section "Thermal Insulation" for insulation beneath the roof deck.
4. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Division 07 Section "Manufactured Roof Expansion Joints" for proprietary manufactured roof expansion-joint assemblies.
6. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Division 22 Section "Plumbing Systems" for roof drains
8. Division 23 – HVAC for mechanical penetrations.
9. Division 26 – Electrical for electrical penetrations.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

SECTION 07 62 00 - 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. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed steep-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.
6. Formed equipment support flashing.
7. Formed overhead-piping safety pans.

- B. Related Sections:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers and sheathing installed in support of flashings.
2. Division 04 Section Unit Masonry for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry
3. Division 07 Sections "Air and Vapor Barrier" and "Vapor-Permeable Air Infiltration Barrier" for installing sheet metal flashing and trim which interfaces with air barriers.
4. Division 07 Sections "Polyvinyl-Chloride Membrane Roofing" for installing sheet metal flashing and trim integral with low-slope roofing.
5. Division 07 Section "Metal Roof Panels" for sheet metal flashing and trim integral with steep-slope metal roof panels.
6. Division 07 Section "Formed Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
7. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, and other manufactured roof accessory units.
8. Division 23 "HVAC" for set-on type curbs and equipment supports.
9. Division 26 "Electrical" for set-on type curbs and equipment supports.

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.

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.

- B. Related Sections include the following:

1. Division 05 Section "Metal Stairs and Railings" for metal ships' ladders and stairs for access to roof hatches.
2. Division 06 Section "Miscellaneous Rough Carpentry" for roof sheathing, wood cants, and wood nailers.
3. Division 07 steep-slope roofing Sections for ridge vents
4. Division 07 low-slope roofing Sections for roofing accessories
5. Division 07 Section "Metal Roof Panels" for preformed metal roofing, ridge vents, and snow guards
6. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and counterflashing, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories
7. Division 23 Section "HVAC Power Ventilators" for power roof-mounted ventilators.
8. Division 26 Sections for power supply and final connections for automatically operated heat and smoke vents
9. Division 28 Section "Fire Detection and Alarm" for interconnects to automatically operated heat and smoke vents

1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

SECTION 07 81 00 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Preparation of surfaces to receive fire-resistant materials.
 - 2. Sprayed fire-resistant materials (SFRM).
 - 3. Repair of fire-resistant materials damaged or removed after initial installation.
 - 4. Thermal Barrier protection for sprayed polyurethane foam insulation.

1.3 DEFINITIONS

- A. SFRM: Sprayed fire-resistant material.
- B. Cementitious: The term cementitious as defined by ASTM and Underwriters Laboratories Inc. applies to all fireproofing that is wet mixed and then pumped as a slurry. Cementitious does not refer to portland cement content.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Conference shall be scheduled at least 2 week prior to the start of installation.
 - 2. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, application parameters and other performance requirements.
 - 3. Conference shall be attended by Architect, Owner's Representative, Owner's Inspection Agent, Contractor, Manufacturer and Installer.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. SFRM
 - a. Provide framing plans, based on approved erection drawings, and accompanying schedules indicating the following:

07 81 00 - 1 of 11

SECTION 07 84 13 - FIRESTOPPING

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:

1. Firestop systems for penetrations through fire-resistance-rated constructions and floor to wall joints, including both empty openings and openings containing penetrating items.
2. Floor-to-floor joints
3. Floor-to-wall joints
4. Head-of-wall joints
5. Wall-to-wall joints

- B. Related Sections include the following:

1. Division 07 Section "Thermal Insulation" for spandrel insulation which is a component of floor-to-wall joints indicated as perimeter fire-containment systems between perimeter edge of fire-resistance-rated floor assemblies and back of non-fire-resistance-rated exterior curtain walls.
2. Division 07 Section "Joint Sealants" for non-fire-resistive joint sealants.
3. Division 07 Section "Expansion Control" for manufactured fire-rated expansion joint systems.
4. Division 21 Sections specifying fire-suppression piping penetrations.
5. Division 22 and 23 Sections specifying duct and piping penetrations.
6. Division 26, 27, and 28 Sections specifying cable and conduit penetrations.

1.3 FIRESTOPPING RATINGS:

- A. F-ratings indicate that the firestopping withstood the fire test for the rating period without the following taking place: flames passing through openings, flaming of any element on the unexposed side of the firestopping system, and any openings developing that permit water from the hose stream to project beyond the unexposed side. F-ratings are required by the 2009 IBC for penetrations in fire-resistance-rated walls and horizontal assemblies.
- B. T-ratings signify that heat transmitted through the firestopping during the rating period did not raise the temperature of any thermocouple on the unexposed firestopping system surface or on any penetrating item by more than 325 deg F above its initial temperature. T-ratings are required by the 2009 IBC.

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Polysulfide joint sealants.
 - 4. Butyl joint sealants
 - 5. Latex joint sealants.
 - 6. Preformed joint sealants.
 - 7. Acoustical joint sealants.
 - 8. Sealant backing, primer and other accessory products

1.3 DEFINITIONS

- A. Sealant: Sealant as indicated on the drawings is defined to include all backing, bond breakers, primers and accessories specified herein and as necessary for a complete sealant installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- 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- (13-mm-)**wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. 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.

SECTION 07 95 13.13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

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 interior expansion joint cover assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
- B. Shop Drawings: For each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by 6 inches (150 mm) long in size.
- D. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.
- E. Samples for Verification: For each type of expansion joint cover assembly, full width by 6 inches (150 mm) long in size.
- F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion joint cover assembly.
 - 2. Expansion joint cover assembly location cross-referenced to Drawings.
 - 3. Nominal, minimum, and maximum joint width.
 - 4. Movement direction.
 - 5. Materials, colors, and finishes.

SECTION 07 95 13.16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

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 exterior building expansion joint cover assemblies.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section
 - 2. Division 07 Section "Sheet Metal Roofing" for sheet metal roof joint systems
 - 3. Division 07 Membrane Roof Sections for expansion joints included in roofing sections.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal wall joint systems

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review manufacturers installation checklist, joint types, movement requirements, loads, joint terminations and transitions and performance requirements.

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 expansion joint cover assemblies.
- B. Shop Drawings: For each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior steel doors and frames.
 - 2. Exterior steel doors and frames.
- B. Related Sections:
 - 1. Division 08 Section "Door Hardware" for door hardware for hollow metal doors
 - 2. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
- C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

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.

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Five-ply flush wood doors for opaque finish.
 - 2. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" for metal door frames.
 - 2. Division 08 Section "Door Hardware" for wood door hardware.
 - 3. Division 08 Section "Glazing" for glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Door core materials and construction.
 - 2. Door edge construction
 - 3. Door face type and characteristics.
 - 4. Door louvers.
 - 5. Door trim for openings.
 - 6. Door frame construction.
 - 7. Factory-machining criteria.
 - 8. Factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
 - 1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
 - 2. Door schedule using same reference numbers for details and openings as those on Drawings. Coordinate with hollow metal and hardware schedules.

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the access doors and frames for walls and ceilings.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for blocking out openings for access doors and frames in concrete.
 - 2. Division 04 Section "Unit Masonry" for anchoring and grouting access door frames set in masonry construction.
 - 3. Division 07 Section "Roof Accessories" for roof hatches.
 - 4. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
 - 5. Division 09 Section "Gypsum Board Systems" for suspended gypsum board ceilings.
 - 6. Division 09 Section "Acoustical Ceilings" for suspended acoustical tile ceilings.
 - 7. Division 23 Section for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of access door and frame indicated.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum **6 by 6 inches (150 by 150 mm)** in size.
- C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of access door(s) and frame(s) through one source from a single manufacturer.
- B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the access doors and frames for walls and ceilings.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for blocking out openings for access doors and frames in concrete.
 - 2. Division 04 Section "Unit Masonry" for anchoring and grouting access door frames set in masonry construction.
 - 3. Division 07 Section "Roof Accessories" for roof hatches.
 - 4. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
 - 5. Division 09 Section "Gypsum Board Systems" for suspended gypsum board ceilings.
 - 6. Division 09 Section "Acoustical Ceilings" for suspended acoustical tile ceilings.
 - 7. Division 23 Section for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of access door and frame indicated.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum **6 by 6 inches (150 by 150 mm)** in size.
- C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of access door(s) and frame(s) through one source from a single manufacturer.
- B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

SECTION 08 33 13 - COILING COUNTER DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Counter doors.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports
 - 2. Division 08 Section "Door Hardware" for lock cylinders and keying
 - 3. Division 09 painting Sections for field-applied paint finish
 - 4. Division 26 Sections for electrical service and connections for powered operators and accessories

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling shutter and accessory. Include the following:
 - 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
 - 3. Include description of automatic closing device and testing and resetting instructions.
- B. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
 - 5. Include diagrams for power, signal, and control wiring.

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Insulated Service doors.

- B. Related Requirements:

- 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
 - 2. Division 08 Section "Door Hardware" for lock cylinders and keying.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.

- 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
 - 3. Include description of automatic closing device and testing and resetting instructions.
 - 4. Summary of forces and loads on walls and jambs.

- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

- 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
 - 5. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
 - 6. Include diagrams for power, signal, and control wiring.

SECTION 08 36 13 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes electrically operated sectional doors.
- B. Related Requirements:
 - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied finishes.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Flat door sections with sensor edge on bottom section.
 - 2. Frame for paneled door sections; of each width of stile and rail required.

SECTION 08 36 13 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes electrically operated sectional doors.
- B. Related Requirements:
 - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied finishes.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Flat door sections with sensor edge on bottom section.
 - 2. Frame for paneled door sections; of each width of stile and rail required.

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Storefront framing.
 - 2. Manual-swing entrance doors.
 - 3. Installation of engineered transition assembly (ETA).
- B. Related Sections:
 - 1. Division 08 Section "All-Glass Entrances and Storefronts" for systems without aluminum support framing.
 - 2. Division 08 Section "Interior Aluminum Frames" for interior aluminum framing.

1.3 DEFINITIONS

- A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work. Shop drawings shall be signed and sealed by the manufacturer's structural engineer.
 - 1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Storefront framing.
 - 2. Manual-swing entrance doors.
 - 3. Installation of engineered transition assembly (ETA).
- B. Related Sections:
 - 1. Division 08 Section "All-Glass Entrances and Storefronts" for systems without aluminum support framing.
 - 2. Division 08 Section "Interior Aluminum Frames" for interior aluminum framing.

1.3 DEFINITIONS

- A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work. Shop drawings shall be signed and sealed by the manufacturer's structural engineer.
 - 1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

SECTION 08 71 00 - DOOR HARDWARE

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. Mechanical door hardware for the following:
 - a. Swinging doors.
 - b. Sliding doors.
- 2. Electronic access control system components, including:
 - a. Electronic access control devices.
- 3. Field verification, preparation and modification of existing doors and frames to receive new door hardware.

- B. Related Sections:

- 1. Division 08 Section "Hollow Metal Doors and Frames" for astragals provided as part of labeled fire-rated assemblies.
- 2. Division 08 Section "Flush Wood Doors" astragals and integral intumescent seals provided as part of labeled fire-rated assemblies.
- 3. Division 08 Section "Overhead Coiling Doors" for door hardware provided as part of overhead door assemblies, except cylinders.
- 4. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for entrance door weather stripping, sweeps, thresholds and finger guards.
- 5. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security system.

1.3 COORDINATION

- A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.

- 1. Cast anchoring inserts into concrete.

- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

SECTION 08 71 13.13 - AUTOMATIC SWING DOOR OPERATORS - LOW ENERGY & POWER ASSIST

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. Low-energy door operators for swinging doors.
- 2. Power-assist door operators for swinging doors.

- B. Related Sections:

- 1. Division 08 Sections for doors and entrances that need reinforcement for automatic door operators.

1.3 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- D. For automatic door terminology, see BHMA A156.19 for definitions of terms.

1.4 COORDINATION

- A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.
- B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
- C. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to the following:
 - 1. Power supplies.
 - 2. Access-control system.
 - 3. Remote activation devices.

4. Remote monitoring 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, dimensions of individual components and profiles, and finishes for automatic door operators.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For low-energy automatic door operators.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Indicate locations of activation and safety devices.
4. Include diagrams for power, signal, and control wiring.

- C. Samples: For each exposed product and for each color and texture specified, manufacturer's standard in size.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Certified Inspector.

- B. Product Certificates: For each operator for fire-rated door assemblies, signed by product manufacturer. Certify that operator is listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.

- C. Field quality-control reports.

- D. Warranty: Sample of special warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project and who employs a Certified Inspector.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. Certified Inspector Qualifications: Certified by the AAADM.

1.10 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of door frames by field measurements before fabrication of exposed covers for automatic door operators.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty or sporadic operation of automatic door operator, including activation and safety devices.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
 - 2. Warranty Period: Two years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Operators: LCN.
 - 2. ADA Operator Switches:
 - a. Camden 331-41S-SGLR
 - b. LCN
 - c. BEA
 - 3. Wireless ADA Operator Switches:
 - a. Camden 330-41S
 - b. LCN
 - c. BEA
 - 4. Power Supplies: Von Duprin
- B. Source Limitations: Obtain automatic door operators, including activation and safety devices, in accordance with Owner's Preferred Brand Alternates list.

2.2 AUTOMATIC DOOR OPERATORS, GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated; and complying with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
 - 1. Emergency Breakaway: Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to automatic door operator when door is in emergency breakaway position, and to return to closed position after breakaway and automatically reset.
 - 2. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
 - 3. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load of <Insert wind load>.
- B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.
- C. Hinges: See Division 08 Section "Door Hardware" for hinge type for each door that door operator shall accommodate.
- D. Housing for Overhead Concealed Operators: Fabricated from minimum **0.125-inch- (3.2-mm-)** thick, extruded or formed aluminum and extending full width of door opening including door jambs to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
- E. Cover for Surface-Mounted Operators: Fabricated from **0.125-inch- (3.2-mm-)** thick extruded or formed aluminum; manufacturer's standard width; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
- F. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.
- G. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.

2.1 LOW-ENERGY DOOR OPERATORS FOR SWINGING DOORS

- A. Standard: BHMA A156.19.
- B. Performance Requirements:

1. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release a latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
 2. Entrapment Protection: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.
- C. Configuration: Operator to control single swinging door.
1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- D. Configuration: Operator to control pair of swinging doors.
1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- E. Operation: Power opening and spring closing. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
- F. Operating System: Electromechanical.
- G. Microprocessor Control Unit: Solid-state controls.
- H. Features:
1. Adjustable opening and closing speed.
 2. Adjustable opening and closing force.
 3. Adjustable backcheck.
 4. Adjustable hold-open time from zero to 30 seconds.
 5. Adjustable time delay.
 6. Adjustable acceleration.
 7. Obstruction recycle.
 8. On-off/hold-open switch to control electric power to operator.
- I. Activation Device: Push-plate switch to activate door operator.
- J. Exposed Finish: Finish exposed components with Class I, clear anodic finish.

2.2 POWER-ASSIST DOOR OPERATORS FOR SWINGING DOORS

- A. Standard: BHMA A156.19.
- B. Performance Requirements:
1. Opening Force:
 - a. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
 - b. Accessible Interior Doors: Not more than **5 lbf (22 N)** to push or pull door to fully open position.

2. Entrapment-Prevention Force: Not more than 15 lbf (67 N) required to prevent stopped door from closing or opening.
- C. Configuration: Operator to control single swinging door.
1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- D. Configuration: Operator to control pair of swinging doors.
1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- E. Operation: Power-assisted opening that reduces the force to open door and[**power-assisted**] spring closing. Pushing or pulling on door activates operator. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
- F. Operating System: Electromechanical.
- G. Microprocessor Control Unit: Solid-state controller.
- H. Features:
1. Adjustable opening and closing speed.
 2. Adjustable opening and closing force.
 3. Adjustable backcheck.
 4. Adjustable hold-open time from zero to 30 seconds.
 5. Adjustable time delay.
 6. Adjustable acceleration.
 7. Obstruction recycle.
 8. On-off/hold-open switch to control electric power to operator.
- I. Exposed Finish: Class I, clear anodic finish.

2.1 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extrusions: **ASTM B221 (ASTM B221M)**.
 2. Sheet: **ASTM B209 (ASTM B209M)**.
- B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness, in manufacturer's standard thickness.
- C. Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in manufacturer's standard thickness.

- D. Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in manufacturer's standard thickness.
- E. Expanded Aluminum Mesh: Expanded and flattened aluminum sheet in accordance with the geometry of ASTM F1267.
- F. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.
- G. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.1 CONTROLS

- A. General: Provide controls, including activation and safety devices, in accordance with BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
- B. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed in plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
 - 1. Provide capability for switching between bidirectional and unidirectional detection.
 - 2. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
- C. Presence Sensors: Self-contained, infrared-scanner units; adjustable to provide detection field sizes and functions required by BHMA A156.10. Sensors shall remain active at all times.
- D. Photoelectric Beams: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams shall not be active when doors are fully closed.
- E. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message.
 - 1. Configuration: Square push plate with 4-by-4-inch (100-by-100-mm) junction box.
 - a. Mounting: Recess mounted, semiflush in wall.
 - 2. Configuration: Rectangular push plate with 2-by-4-inch (50-by-100-mm) junction box.
 - a. Wall Mounting: Recess mounted, semiflush in wall.
 - b. Post Mounting: Recess mounted on post.
 - 3. Push-Plate Material: Stainless steel, brushed #4 finish.
 - 4. Message: International symbol of accessibility and "Push to Open."
- F. Touchless Switch: Hands-free activation door-control switch with flat motion sensor face-plate with contrasting-colored, engraved message.

1. Configuration: 4.56-by-4.56-inch (115.8-by-115.8-mm) (double gang) square face plate.
 - a. Mounting: Recess mounted in wall.
 2. Face-Plate Material: Stainless steel.
 3. Message: International symbol of accessibility and "Wave to Open" and wave symbol.
- G. Push-Button Switch: Momentary-contact door control switch with one red-button actuator; enclosed in nominal 2-by-4-inch (50-by-100-mm) junction box.
1. Provide faceplate engraved with "Press to Open" text and international symbol of accessibility in contrasting color.
 2. Provide blue plastic cover engraved with "Press Button to Open" in white text and international symbol of accessibility.
 3. Mounting: Recess mounted in wall.
 4. Faceplate Material: Stainless steel as selected by Architect from manufacturer's full range.

2.2 ACCESSORIES

- A. Signage: As required by cited BHMA standard for type of door and its operation.
1. Application Process: Operator manufacturer's standard process.
 2. Provide sign materials with instructions for field application when operators are installed.

2.3 FABRICATION

- A. Factory fabricate automatic door operators to comply with indicated standards.
- B. Form aluminum shapes before finishing.
- C. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.
- D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
- E. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

2.4 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary, protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install automatic door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
 - 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 - 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
 - 3. Low-Energy Door Operator Installation Standard: BHMA A156.19.
- B. Controls: Install activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel.
 - 1. Power Connection: See Division 26 Sections for connection to electrical power distribution system.
- C. Activation and Safety Devices: Install devices and wiring according to manufacturer's written instructions and cited BHMA standard for type of operator and direction of pedestrian travel. Connect activation- and safety-device wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Access-Control System: Connect operators to access-control system as specified in Division 28 Section "Access Control."

- E. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 FIELD QUALITY CONTROL

- A. Certified Inspector: Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Test and inspect each automatic door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
- C. Automatic door operators will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust operators on exterior doors for weathertight closure.
- B. After completing installation of exposed, factory-finished automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust automatic door operators after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- D. Occupancy Adjustment: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

END OF SECTION 08 71 13.13

SECTION 08 80 00 – GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Storefront framing.
 - 2. Interior and Exterior Doors, except where noted otherwise.
 - 3. Interior borrowed lites; including glazed openings, transoms and sidelights, except where noted otherwise.
- B. Section includes transparent and translucent glass glazing for general and special purpose applications including; coated, float, heat-strengthened, impact resistant, insulating, low emissivity, laminated, spandrel and tempered glass.
- C. Section includes the manufacture, handle, deliver and install glazing systems as shown on the architectural drawings or as otherwise specified and in accordance with the requirements of the contract documents.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in the referenced glazing publications.
 - 1. For this specification, manufacturer shall be defined as the firm that produces the primary glass.
 - 2. For this specification, fabricator shall be defined as the firm that modifies the primary glass by coating, heat treating, laminating and creating insulating glass fabrications.
 - 3. For this specification, installer shall be defined as the firm who receives the glazing products from the fabricator and installs them on the project.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
- C. IBC: International Building Code.
- D. Interspace or Airspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

SECTION 08 87 00 – GLAZING SURFACE FILMS

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 Window Film.
- B. Related Requirements:
 - 1. Division 08 Section “Glazing” for general glazing applications to receive architectural window film.

1.3 PERFORMANCE REQUIREMENTS

- A. Fire Performance: Surface burning characteristics when tested in accordance ASTM E84: Flame Spread: 25, maximum; Smoke Developed: 450, maximum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include location plans and elevations indicating which film types will be applied and where films will be applied.
- C. Samples: For each product and for each film color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of ten (10) years experience.

SECTION 08 91 19 – FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Fixed, extruded-aluminum louvers.
- 2. Screens and blank-off panels for louvers.

- B. Related Sections:

- 1. Division 04 Section "Unit Masonry" for wall vents (brick vents) for masonry.
- 2. Division 07 Section "Metal Panels" for louvers integral with insulated metal panels.
- 3. Division 08 Section "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
- C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

SECTION 09 29 00 - GYPSUM BOARD SYSTEMS

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. Specialty gypsum board
3. Gypsum shaft liner.
4. Cement board backing panels.
5. Gypsum board shaft wall assemblies.
6. Non-load-bearing steel framing systems for interior partitions.
7. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
8. Marking and Identifying Fire and Smoke Rated Assemblies.

- B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for moisture and mold field quality control procedures.
2. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing wall studs.
3. Division 06 Section "Sheathing" for gypsum sheathing for exterior walls.
4. Division 07 Section "Firestopping" for head-of-wall assemblies that incorporate gypsum board
5. Division 13 Section "Radiation Protection" for lead-lined gypsum wallboard

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. System Assemblies:

1. Provide schedule of all UL approved system assembly numbers and descriptions for each UL approved wall assembly to be installed in the work.
2. Provide schedule of all STC assembly designs and descriptions for each required Sound Transmission Class wall to be installed in the work.

- C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-)long length for each trim accessory indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Delegated Design: Provide load calculations for Grid Suspension System for Gypsum Board Ceilings (reference Part 2) which includes structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Load calculations for system, shall include those imposed by lighting, air distribution terminals, fire suppression and all other supplementary loads on the grid system.
- B. Provide Contractor's certification that all required rated assemblies are constructed in accordance with UL design tests or GA-600 including penetrations, door frames, etc., and that all rated door openings meet ASTM E152.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. 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. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for the following:
 - a. Level 5 gypsum board finish indicated for use in exposed locations.
 - 2. Apply or install final decoration indicated, including painting and wall coverings, on exposed surfaces for review of mockups.
 - 3. Simulate finished lighting conditions for review of mockups.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.
- B. 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.

1.6 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 and GA 220 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are 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.
- D. Room Temperatures: For attachment of gypsum board to framing, maintain not less than **40° F (4° C)**. For finishing of gypsum board maintain not less than **50° F (10° C)** for 48 hours before application and continuously after until dry. Do not exceed **95° F (35° C)** when using temporary heat sources. Gypsum board shall not get wet.
- E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

1.8 WARRANTY

- A. Provide 2 year written product and installation warranty in accordance with Division 01 "Product Requirements."
- B. Repair and/or replace any cracking, loosening, nail popping or other defects in the material or workmanship, including improper installation of framing, bracing and control joints, of the gypsum board systems during warranty period.

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 E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of **5 lbf/sq. ft. (239 Pa)**.

2.2 GYPSUM BOARD, GENERAL

- A. Panel 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Gypsum
 2. CertainTeed Corp.
 3. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific
 4. Continental Building Products
 5. National Gypsum Company
 6. USG Corporation
- B. Interior Gypsum Board Density: Lightweight panel products are not acceptable. All gypsum board products shall have a minimum weight of 2.1 pounds per square foot of 5/8 inches thick board (40.3 pounds per cubic foot).
- C. Regular Type X: ASTM C1396/C1396M
1. Thickness: 5/8 inch (15.9 mm)
 2. Long Edges: Tapered
- D. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
1. Core: 5/8 inch (15.9 mm), Type X.
 2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
 3. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
 4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
 5. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
 6. Long Edges: Tapered.
 7. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- E. Mold-Resistant Type: ASTM C1396/C1396M. With moisture- and mold-resistant core and surfaces.
1. Core: 5/8 inch (15.9 mm), Type X
 2. Long Edges: Tapered
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 SPECIALTY GYPSUM BOARD

- A. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Continental Building Products; Weather Defense Platinum Interior Type X
 - b. Panel Rey; Glass Rey Interior Sheathing Board
 - c. USG Corporation; Sheetrock Brand Glass-Mat Panels.
 - d. Certainteed Corporation; GlasRoc Interior Glass-Mat Panels Type X.

2. Core: **5/8 inch (15.9 mm)**, Type X.
3. Finishing:
 - a. Tape and spackle joints and screw holes per manufacturer's recommendation.
 - b. Apply skim coat to sheathing board using setting-type, sandable topping compound.

2.5 GYPSUM SHAFTLINER

- A. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum: M-BLOC Shaft Liner.
 - b. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
 - c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
 - d. Continental Building Products; Firecheck Moldcheck Type X Shaftliner.
 - e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
 - f. PABCO Gypsum; Pabcore Mold Curb Shaftliner Type X.
 - g. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
 2. Core: **1 inch (25.4 mm)** thick
 3. Long Edges: Double bevel
 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 CEMENTITIOUS BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or 1325, with manufacturer's standard edges.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. FinPan, Inc.; Util-A-Crete Concrete Backer Board
 - b. National Gypsum Company, Permabase Cement Board.
 - c. USG Corporation; DUROCK Cement Board.
 2. Thickness: **5/8 inch (1.59 mm)**.
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047. Provide longest possible lengths.
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - a. USG Corporation
 - b. ClarkDietrick

- c. MarinoWare
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. Control joint: Zinc control joint.
 - f. Curved-Edge Cornerbead: With notched or flexible flanges

2.8 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M and GA 216.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Glass-Mat Faced Gypsum Board: As recommended by panel manufacturer.
 - 3. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints beveled panel edges, and damaged surface areas, use drying-type taping compound, except use setting-type for abuse resistant drywall.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type taping compound, except use setting-type for abuse resistant drywall.
 - 3. Fill Coat: For second coat, use drying-type, sandable topping compound, except use setting-type for abuse resistant drywall.
 - 4. Finish Coat: For third coat, use drying-type, sandable topping compound, except use setting-type for abuse resistant drywall.
 - 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Cementitious Backer Units: Setting mortar as recommended by backer unit manufacturer.
 - 2. Tile Setting Mortar: Per Division 09 Section "Tiling".

2.9 STEEL FRAMING SYSTEMS

- A. **Recycled Content of Steel Products:** Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Steel Stud Manufacturers Association (SSMA) nomenclature, as indicated in their Product Technical Guide, is used for identification of steel studs.
- C. Framing Members, General: Comply with ASTM C754 and ASTM C1007 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 and ASTM C955 requirements for metal unless otherwise indicated.
 2. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ClarkDietrich Building Systems
 - b. Marino/Ware
 - c. Telling Industries
 3. Protective Coating: Minimum ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
 - a. Equivalent coatings are not permitted.
- D. Steel Studs:
1. 36S137-33 (3-5/8" web depth stud with minimum base metal thickness of 0.033 inch, minimum flange width of 1.375" and minimum stiffening lip length of 0.375").
 - a. Other Web Depths: As indicated on Drawings.
- E. Runners:
1. Slip-Type Head Joints: Provide the following:
 - a. Single Long-Leg Runner System: Top runner with minimum 2-1/2-inch- (63.5-mm) deep flanges in thickness as scheduled below, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (304.8 mm) of the top of studs to provide lateral bracing.
 - 1) Stud length up to 12'0": minimum top runner base metal thickness; .033 inch.
 - 2) Stud length 12'0" to 22'0": minimum top runner base metal thickness: .043 inch
 - 3) Stud length up to 24'0": minimum top runner base metal thickness: .054 inch.
 2. Partition top runner which does not extend to structure: 1-1/4 inch (31.75 mm) leg of thickness and size to match studs.
 3. Bottom Runner: 1-1/4 inches (31.75 mm) leg of thickness and size to match studs, typical.
- F. Concealed Blocking: See requirements for concealed blocking in Part 3 of this Section.
- G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-(3.81 mm-) wide flanges.
1. Depth: 1-1/2 inches (3.81 mm).
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (3.81 x 3.81 mm), 0.068-inch-thick, galvanized steel.
- H. Blocking and Strapping: Permitted only where interferences prevent the installation of Cold Rolled Channel Bridging noted above.
1. Blocking: 0.033 inch track sections clipped to studs.

2. Strapping: 2 - 12 inches wide steel strap bracing, 0.033 inch by 10 feet.
- I. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base-Metal Thickness: 0.030 inch.
 2. Depth: 7/8 inch (22.23 mm).
- J. Resilient Clips: molded rubber and steel resilient sound isolation clips to receive 7/8 inch hat channel furring.
 1. Manufacturers:
 - a. Basis of Design: Pliteq GenieClip Resilient Sound Isolation Clip.
 - b. Other Acceptable Manufacturers subject to compliance with requirements:
 - 1) Acoustical Surfaces, Inc. RSIC-1
 - 2) Kinetics Noise Control Inc. Isomax
- K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.75 mm), wall attachment flange of 7/8 inch (22.23 mm), minimum uncoated-metal thickness of 0.018 inch (2.81 mm), and depth required to fit insulation thickness indicated.

2.10 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated.
- B. STC Rating: As indicated.
- C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 1. Depth: As indicated.
 2. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- D. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (5.08) long and matching studs in depth.
 1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- E. Protective Coating: Minimum ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- F. Room-Side Finish: As indicated.
- G. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X.
- H. Concealed Blocking: See requirements for concealed blocking in Part 3 of this Section.

2.11 GYPSUM BOARD CEILING SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-(1.58 mm) diameter wire, or double strand of 0.048-inch-(1.22 mm-) diameter wire.
- B. Hanger Attachments to Concrete:
1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488 by an independent testing agency.
 - a. Type: Cast-in-place anchor, designed for attachment to concrete forms or post-installed, expansion anchor.
 2. Powder-Actuated Fasteners: Suitable fastener for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E1190 by an independent testing agency.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.106 inch (2.69 mm) in diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.346 mm) and minimum 1/2-inch-(12.7 mm-)wide flanges, G40 (G60 where subject to moisture) galvanized steel.
1. Depth: 1-1/2 inches (12.7 mm).
- E. Furring: G40 (G60 where subject to moisture and under cement board) galvanized steel, hat channel, minimum size SSMA 150F125-33 (20 gauge structural, minimum 0.0329 inch uncoated steel thickness).
- F. In lieu of traditional carrying channel (black) iron and hat track, or stud and track suspension system, contractor may use suspended grid or "T-bar" construction. Should this option be elected, the contractor shall be responsible to provide load calculations for review and approval as required in Part 1 of this Section.
1. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Armstrong World Industries, Inc.; Drywall Grid Systems
 - 2) Chicago Metallic Corporation; Drywall Grid System
 - 3) USG Corporation; Drywall Suspension System
 - b. T-bar construction shall meet or exceed all requirements of this specification and local codes.
 - c. Minimum G60 hot dipped galvanized coating and .0179 steel thickness before application of protective coating.

2.12 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool. Blankets shall be the proper width and depth required to completely fill the stud/drywall cavity and prevent sag. Blankets installed where drywall is not applied on each side of the stud shall be mechanically held in place.
 - 1. For use in non-fire rated wall and ceiling assemblies.
 - 2. Basis of Design: Thermafiber Mineral Wool Batt
 - 3. Other acceptable manufacturers subject to compliance with requirements;
 - a. Roxul Mineral Wool Batt.
 - b. Johns Manville; Fiberglass Batts for Metal Framing.
 - c. Owens Corning; Fiberglass Thermal Batt for Metal Framing.
- D. Fire-Resistive Blankets: ASTM C665, Type I (blankets without membrane facing); consisting of slag wool or rock wool fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics. Blankets shall be the proper width and depth required to completely fill the stud/drywall cavity and prevent sag.
 - 1. Fire-Resistance-Rated Assemblies: Install mineral-fiber as required to comply with the requirements of the approved assembly.
 - 2. Basis of Design: Thermafiber Mineral Wool Batt
 - 3. Other acceptable manufacturers subject to compliance with requirements;
 - a. Roxul Mineral Wool Batt.
- E. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226, 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.
- F. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- G. Acoustical Joint Sealant: As specified in Division 07 Section "Joint Sealants"
- H. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

- I. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."
- J. Fire Safing: As specified in Division 07 Section "Firestopping".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates to which gypsum board assemblies attach or abut, including hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 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.
- D. Commencement of installation indicates acceptance of substrate.

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. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of steel framing and shaft wall assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing."
- C. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Extend gypsum board to height as indicated on drawing.

- C. Protect gypsum board products from direct exposure to rain, snow, sunlight, or other excessive weather conditions.
- D. 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.
- E. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch (1.5875 mm)** of open space between panels. Do not force into place.
- F. 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.
- G. Form control and expansion joints with space between edges of adjoining gypsum panels.
- H. Cover both faces of support framing with gypsum panels in concealed spaces.
 - 1. Fit gypsum panels around ducts, pipes, and conduits.
 - 2. 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-(6.35 to 9.53 mm-)**wide joints to install sealant.
- I. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide **1/4- to 1/2-inch- (0.64 to 1.27 mm-)**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.
- J. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- K. 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 C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- L. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.4 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: As indicated on Drawings and vertical surfaces unless otherwise indicated.
 - 2. Flexible Type: Apply in double layer at curved assemblies.
 - 3. Abuse-Resistant Type: As indicated on Drawings.
 - 4. Moisture- and Mold-Resistant Type: As indicated on Drawings.
 - 5. Acoustically Enhanced Type: As indicated on Drawings.
 - 6. Glass-Mat Faced Gypsum Type: As indicated on Drawings.

B. Single-Layer Application:

1. Apply single layer gypsum board in fire rated partitions as required by the fire resistance rated assembly.
2. Erect all gypsum board on ceilings perpendicular to framing with staggered end joints over supports.
3. End joints shall be avoided where possible. Apply single layer gypsum board in non-fire rated partitions either vertically with edges over framing or horizontally with ends over framing as required to minimize the number of end joints.
 - a. Install vertical boards in lengths required to exceed the ceiling height were possible.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On multi-layer partitions/walls, apply gypsum board panels per fire resistive rated assembly and STC rated assembly requirements.
2. On all other multi-layer partition/walls, apply the first layer in the opposite direction as second layer with all ends over framing. Erect the second layer either vertically with edges over framing or horizontally with ends over framing as required to minimize the number of end joints.
 - a. Install vertical boards in lengths required to exceed the ceiling height were possible.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.5 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: Install compliant with ANSI A108.11 at showers, tubs and at all locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- C. Under all ceramic wall tiles, erect **5/8 inch-(1.59 mm-)** thick cement board with as few joints as possible. Apply rough side out. Where ceramic tile is not full height of wall, top of cement board shall be **2 inches (5.08 mm)** below top of ceramic. Embed **2 inch (5.08)** interior tape in a skim coat of dry-set cement mortar over the joints and corners.
- D. Shower Cubicles: Under ceramic tile, erect **5/8 inch-(1.59mm-)**thick cement board with single sheet covering full wall width, extending from shower receptor to ceiling and from corner to corner. Apply rough side out. Provide 1/4 inch wide open joints between shower receptor [bathtub rim] and wallboard. Joint to be filled with sealant. Embed **2 inch (5.08 mm)** interior tape in a skim coat of dry-set cement mortar over the joints and corners.
- E. Joints/Cement Board: Tape, fill, finish joints, corners, etc., to produce surface ready to receive surface finish. Full finishing must extend behind base to floor. Material shall be tile setting mortar with cement board tape; it shall not be sheetrock joint compound and paper tape.
- F. Treat cut edges and holes with sealant.

3.6 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: Location of control joints shall be consistent with lines of building spaces, in consistent pattern and as directed by Architect at **30 feet (914.4 cm)** o.c., maximum except provide control joints strike side of door frame on both sides of partition, extending from top of frame to **6 inches (15.24 mm)** above ceiling.
 - 1. Install vertical control joints in UL rated assemblies with additional type X drywall behind the control joint, as indicated, to preserve the integrity of the assembly.
- 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. Control Joint: Use at GWB control joints
- D. Aluminum Trim: Install in locations indicated on Drawings per manufacturer's instructions.
 - 1. Install horizontal trim in UL rated assemblies with an additional layer of type X drywall behind the trim or by installing the appropriately sized Blaze Frame FSB intumescent backer, per manufacturers written instructions.

3.7 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, rounded or beveled edges, 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. Joints/Gypsum Wallboard: Tape, fill, finish and sand joints, fasteners, corners, metal trim flanges, to produce surface free of visual defects ready to receive surface finishes. Full finishing shall extend behind base to floor. Tape and fill all joints in concealed locations. Treat all fastener heads in concealed locations with one coat of joint compound.
- E. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - a. All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges shall be acceptable.

2. Level 2: Where panels form substrate for tile and acoustical tile and where indicated on Drawings.
 - a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
3. Level 3: For gypsum board surfaces receiving medium or heavy textured finishes before painting and for surfaces receiving heavy-duty wall coverings where lighting conditions are not critical.
 - a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. One additional coat of joint compound shall be applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated and unless scheduled to receive gloss or semi-gloss paint finishes.
 - a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges.
 - b. Primer and its application to surfaces are specified in Division 09 Section "Interior Painting."
5. Level 5: Where indicated on Drawings and Finish Schedule (Gloss and semi-gloss paint finishes require a level 5 finish).
 - a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be trowel-applied to the entire surface. Excess compound is immediately sheared off, leaving a film of skim coating compound completely covering the paper. As an alternate to a skim coat, a material manufactured especially for this purpose shall be applied. The surface shall be smooth and free of tool marks and ridges.
 - b. Primer and its application to surfaces are specified in Division 09 Section "Interior Painting."
 - c. See Finish Schedule and Division 09 Section "Interior Painting" for scheduled paint finishes which require a level 5 finish.

- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- G. Glass-Mat Interior Gypsum Board: Finish according to manufacturer's written instructions.

3.8 FRAMED ASSEMBLY AND SHAFTWALL INSTALLATION, GENERAL

- A. Install framed gypsum board and shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, ASTM C754 and ASTM C1007 other than stud-spacing requirements.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install bracing at terminations in assemblies.
- C. Do not bridge building control and expansion joints with non-load-bearing steel framing or shaftwall assembly members. Frame both sides of joints independently.
- D. Do not attach runners, studs, bracing, or any other component of partition or ceiling system to ducts, pipes, equipment, etc. Attach only to building floors, walls or structural framing.
- E. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work which are to be placed in or behind partition framing. Allow such items to be installed after framing is complete.
- F. Resilient Clips: Provide and install resilient clips and furring channels in strict accordance with manufacturer's recommendations as required to maintain the design intent for acoustical properties of the assembly. Do not use resilient clips which have been damaged or distorted in any way. Place resilient clips at the minimum spacing recommended by the manufacturer to achieve the required acoustical properties. Drywall attached to the resilient clip may not touch drywall on the adjoining wall. Do not load the resilient clip with drywall heavier than recommended by the manufacturer. Do not allow electrical junction boxes, etc. to be attached to the stud and also the drywall supported by the resilient clip. Use only non-drying non-skinning sealant around electrical boxes, etc. where they penetrate drywall supported by resilient clips. If the ceiling is also resilient, the walls and the ceiling cannot touch each other, i.e., install walls before ceiling.

3.9 INSTALLING STEEL FRAMING ASSEMBLIES

- A. Install framing system components according to spacing indicated, but not greater than spacing required by referenced installation standards for assembly types.
- 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. Bracing: For partitions which do not extend to structure above, provide diagonal bracing spaced maximum 48 inches on centers on alternate sides of partitions and at double studs on each side of door frames, extending from top of partition to underside of structure above.

- E. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above ceilings except where otherwise indicated. Continue framing around ducts penetrating 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. Install with studs friction fit into top runner and with continuous bridging located within **12 inches (304.8mm)** of the top of studs to provide lateral bracing.
 2. Fasteners: Use fasteners to connect each flange of each stud to both top and bottom runners except do not fasten studs to top runner at slip-type head joint.
- F. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb with “U-shaped” strap anchors to join studs together; space straps at maximum **24 inches (609.6 mm)** on center and maximum **4 inches (101.6 mm)** from end of studs.
 2. Base metal thickness of jamb studs shall be the greater of the thickness of adjacent studs or 0.033 inch.
 3. Install cripple studs at head adjacent to each strike side jamb stud, with a minimum **1/2-inch (12.7 mm)** clearance from jamb stud to allow for installation of control joint in finished assembly.
 4. Extend double jamb studs through ceilings and attach to top runner.
 - a. For partitions terminating at structure above, into a slip-type head joint, or
 - b. For partitions not terminating at structure above, fastened to top runner; diagonally brace double studs at each side of door frame to structure above.
- G. 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.
- H. 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.
- I. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- J. Curved Partitions:
1. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 2. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6 inches (152.4 mm)** o.c.
- K. Direct Furring:
1. Screw to wood framing.
 2. Attach to substrate with suitable fasteners spaced **24 inches (609.6 mm)** o.c., for concrete or masonry with screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (609.6 mm)** o.c.

L. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced **24 inches (609.6 mm)** o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (609.6 mm)** o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches (304.8 mm)** from corner and cut insulation to fit.

M. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3.175 mm)** from the plane formed by faces of adjacent framing.

N. Bridging: Install continuous horizontal cold rolled channel bridging within stud cutout:

1. Spaced **4 feet (1.22 m)** on center vertically for all partitions which do not have gypsum wallboard installed continuously on both sides of partition
2. Spaced **4 feet (1.22 m)** on center vertically where stud length exceeds **14 feet (4.27 m)**.
3. Within **1 foot (.31 m)** of the deflection track where partition is full height to structure above
4. Spaced **4 feet (1.22 m)** on center vertically where there is additional surface loading on the partition, including, but not limited to, ceramic tile, wall cabinets, countertops and lead lining.

O. Blocking/Strapping: Install continuous blocking and strapping only where interferences prevent the installation of bridging channels.

1. Install solid blocking **0.033-inch (.84 mm)**-thick runners at each end of wall and at every 8 feet on center maximum.
2. Install **0.033 inch (.84 mm)** continuous metal strapping fastened to each side of metal framing studs. Strapping shall be **2 inches (50.8)** wide minimum.

P. Flush Mounted Countertop Support: Each flush mounted countertop support shall be attached to two studs, each with minimum base metal thickness of **0.033 inch (.84 mm)**. Wood blocking which is of the full cross-sectional dimension of the stud and **12 inches (304.8 mm)** longer than the countertop support shall be provided in each stud. The countertop support shall be connected to the studs and blocking with minimum three bolts with double nuts or lock washers. Studs shall also be connected with minimum three U-shaped straps.

3.10 INSTALLING GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Provide bracing where shaftwall exceeds **10 feet (304.8 cm)** in height.

- B. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices and similar items.
- C. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3.18 mm)** from the plane formed by faces of adjacent framing.

3.11 INSTALLING CONCEALED BLOCKING

- A. Provide blocking concealed in partitions at every location where a fixture or other appurtenance is supported by the partition. Blocking shall be installed horizontally from stud to stud and be positively connected to each stud in a manner so that it supports each fixture or appurtenance. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved. Install blocking for support of all fixtures and other appurtenances including but not limited to toilet partitions, wall cabinets, countertops, casework, millwork, handrails, bumper rails, shelving, toilet accessories, mirrors, wall mounted equipment, hardware including wall door stops, and other wall mounted items. Contractor shall notify the Architect before installing fixtures or other appurtenances weighing in excess of 250 lbs.
 - 1. For fixtures or other appurtenances which weigh 25 lbs. or less attach directly to a minimum **0.033-inch-(.84 mm-)**thick, **3 5/8-inch-(92.08 mm-)**wide steel stud section or a 16 gauge cold rolled steel plate, minimum **6-inch-(152.4 mm-)**wide installed horizontally from stud to stud. Fasten with minimum two low profile pan head #8-18 screws at each stud.
 - 2. For fixtures or other appurtenances which weigh more than 25 lbs. but less than 250 lbs. or are supporting live loads of more than 25 lbs. (i.e. handrails) attach directly to one of the following:
 - a. Provide 2 x 10 nominal fire-treated wood blocking; attach blocking to each stud with minimum three **1¼-inch-(31.75 mm-)**long #10 wood screws; space top and bottom wood screws **½ inch (12.7 mm)** from end of wood; do not attach screws into wood end grain; avoid wood end grain by providing a minimum **0.033-inch- (1.17 mm-)**thick steel clip angle; install minimum three low profile pan head #8-18 sheet metal screws to connect steel clip angle to stud; kerf blocking to accommodate stud lip.
 - b. Provide **¾ inch x 24 inches (19.05 x 609.6 mm)** minimum wide fire-treated plywood blocking; attach blocking to each stud with minimum four 1” long #10 wood screws; space top and bottom wood screws ½” from end of wood; do not attach screws into wood end grain; avoid wood end grain by providing a minimum **0.033-inch-(1.17 mm-)**thick steel clip angle; install minimum four #8-18 sheet metal screws to connect steel clip angle to stud; kerf blocking to accommodate stud lip.
 - c. Manufactured wood plywood backing plate:
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following: ClarkDietrich Building Systems; Danback Fire-Treated Wood Backing Plate.
 - 2) Install Danback Backing plate per manufacturer’s written instructions and per published load data, but with a minimum of two screws per stud.

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- d. Provide 0.054-inch-(1.37 mm)-thick nested steel stud and runner; secure stud to runner with 4- # 8 pan head framing screws top and bottom; connect blocking to studs with minimum 0.054 inch-(1.37 mm)-thick cold rolled plates; provide minimum three #8-18 low profile pan head framing screws in each cold rolled plate connection.
3. Shower Seat: Wall mounted shower seats shall be installed as follows:
 - a. Studs supporting the shower seat blocking (up to three) shall be minimum 0.033 inch (1.17 mm) thick, 3 5/8-inch-(92.08 mm)-wide steel studs with minimum of three "U" shaped strap anchors to join studs together. Extend the double studs from floor to 1/2 inch (13 mm) short of underside of structure above seated into 2-1/2 to 3 inch deep leg runner track. Maximum stud height shall be limited to 16 ft. 0 in (4.88 m).
 - b. Provide 2 x 10 nominal fire-treated kerfed wood blocking attached to double studs with a minimum three (3) 1 1/4-inch-(31.75 mm-) long #10 wood screws at each end of each piece of blocking; space top and bottom wood screws 1/2 inch (12.7 mm) from end of wood; do not attach screws into wood end grain; install minimum three #8-18 sheet metal screws at each steel stud/steel stud connection as required to secure a 20 ga. clip on the backside. Add an additional row of wood blocking as required to capture all shower seat attachment points.
 - c. Secure the shower seat to the wood blocking with the #14 x 2-1/2" stainless steel mounting screws furnished by the manufacturer.

3.12 INSTALLING GYPSUM BOARD CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacing indicated, but not greater than the following spacing:
 1. Hangers: 48 inches (121.92 cm) o.c.
 2. Carrying Channels (Main Runners): 48 inches (121.92 cm) o.c.
 3. Furring Channels (Furring Members): 16 inches (406.4 mm) o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interferes with locations of hangers required to support standard suspension system members, the Contractor shall 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 L/360 deflection limit.
 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. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 7. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications
 8. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 9. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 10. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. 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.
- E. Seismic Bracing: Sway-brace suspension systems.
- F. Installation Tolerances: Install suspension systems that are level to within **1/8 inch in 12 feet (3.75 mm in 365.76 cm)** measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
- G. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum **24 inches (609.6)** past each end of openings.
- H. Ceiling grille for ceiling areas with large openings for recessed lighting or to meet HVAC requirements.
1. Main runner channels - **1-1/2 inches (38.1 mm)** deep, not over **48 inches (121.92 cm)** o.c. secured to structure with **3/16 inch x 1 inch (4.76 x 25.4 mm)** asphaltum coated steel flat bar hangers not over 4 feet o.c.
 2. Cross furring - **3-5/8 inch (92.08 mm)** stud channels at **24 inches (60.96 cm)** o.c., wire tied or clipped to **1-1/2 inch (38.1 mm)** runner channels
 3. Perimeter of recessed light and grille opening shall be formed with **3-5/8 inch (92.08 mm)** stud channels, tied into adjacent furring system. Provide **3/16 inch x 1 inch (4.76 x 25.4 mm)** asphaltum coated steel flat bar hangers at all corners with additional hangers at **4 feet (121.92 cm)** o.c. or as required to support lights, grilles or other items of equipment supported from the ceiling suspension system.

3.13 MARKING AND IDENTIFYING FIRE AND SMOKE RATED WALL ASSEMBLIES

- A. Provide stenciled identification on all fire walls, fire partitions, smoke barriers and smoke partitions, or on any other wall required to have protected openings or penetrations.
1. Stencil shall be located in accessible concealed floor, floor-ceiling or attic spaces, generally above the finished ceiling.
 2. Stencil shall be repeated at intervals not exceeding **30 feet (914 mm)** measured horizontally along the wall or partition.

3. Stencil shall include lettering not less than 3 inches in height, be visible from the floor and shall incorporate the suggested wording: “FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS,” or other lettering height or wording approved by the Authority Having Jurisdiction.

3.14 MOISTURE AND MOLD FIELD QUALITY CONTROL

- A. Reference Division 01 Section “Temporary Facilities and Controls” for moisture and mold field testing and remediation procedures applicable to the work of this section.

3.15 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 09 29 00

SECTION 09 30 00 – TILING

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: Interior ceramic tile selection and installation.
 - 1. Tile.
 - 2. Waterproofing and crack isolation membrane.
 - 3. Setting materials and accessories.
 - 4. Metal edge strips.
- B. Related Sections:
 - 1. Division 09 Section "Gypsum Board Systems" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Reference to the TCNA shall be defined in this section to mean the TCNA (Tile Council of North America) Guidelines, latest edition.
- C. Porcelain Tiles are ceramic tiles for wall and floor application and are pressed or extruded. Porcelain tiles are classified impervious per ASTM C373.
- D. Glazed Wall Tiles are nonvitreous ceramic tiles intended for interior use on walls only.
- E. Module Size: Actual tile size plus joint width indicated.
- F. Face Size: Actual tile size, excluding spacer lugs.
- G. Small Format Tile: Tile less than 15 inches in any one dimension, unless noted otherwise.
- H. Large Format Tile: Tile equal to or greater than 15 inches in any one dimension, unless noted otherwise.
- I. Lippage: The condition where one edge of a tile is higher than the adjacent tile edge, giving the finished surface an uneven appearance.

SECTION 09 51 00 - ACOUSTICAL BAFFLE CEILINGS 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. This Section includes acoustical baffle panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.
- C. Related Sections
 - 1. Section 09 20 00 - Gypsum Board, Framing & Accessories
 - 2. Division 23 – Heating, Ventilating and Air Conditioning (HVAC)
 - 3. Division 26 – Electrical
- D. AC: Articulation Class
- E. CAC: Ceiling Attenuation Class
- F. LR: Light Reflectance coefficient
- G. NRC: Noise Reduction Coefficient

1.3 REFERENCES

- A. ASTM E84-14 CLASS A / CAN ULC S102: Standard Test Method for Surface Burning Characteristics of Building Materials; 1991
- B. ASTM C423-90A: Standard Test Method for Sound Absorption Coefficients by the Reverberation Room Method; 1990

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

SECTION 09 51 13 - ACOUSTICAL CEILINGS

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 acoustical panels and exposed suspension systems for interior ceilings.
- B. Related Sections include the following:
 - 1. Division 08 Section "Suspended Decorative Grids"
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

- A. AC: Articulation Class
- B. CAC: Ceiling Attenuation Class
- C. LR: Light Reflectance coefficient
- D. NRC: Noise Reduction Coefficient

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For components with factory-applied color finishes.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of full-size Samples of each type, color, pattern, and texture.

SECTION 09 62 53.13 - SHEET CARPETING – SYNTHETIC TURF

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. The work of this section includes:
 - 1. Synthetic turf carpet.
 - 2. Adhesives.

1.3 PREINSTALLATION MEETINGS

- 1. Review methods and procedures related to carpet installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit product data, including manufacturer's guide specifications product sheet and installation instructions for specified products.
- B. Shop Drawings: Submit shop drawings showing layout, profiles, and product components, including anchorage, accessories, finish colors, patterns, and textures. Include field markings and decorations as indicated on the Drawings.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet: **12-inch (300-mm)** square or sufficiently sized to clearly indicate pattern Sample.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Thermoset-rubber base.
2. Rubber stair accessories.
3. Rubber molding accessories.

- B. Related Sections:

1. Division 09 Section "Resilient Flooring" for resilient floor coverings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1. Include product data specific to accessory adhesives for each specified product.

- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.

- C. Samples for Initial Selection: For each type of product indicated.

- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long.

- E. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Provide Architect with test procedure or ASTM number, required results for acceptability accompanied by actual test results (from independent testing laboratory where required), and

SECTION 09 65 16 – RESILIENT TILE AND SHEET 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. Unbacked rubber sheet flooring.
 - 2. Solid vinyl floor tile.
- B. Related Sections:
 - 1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. With product data for each floor finish material specified, provide manufacturer's slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.
- B. Shop Drawings: For each type of resilient sheet flooring.
 - 1. Include sheet flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than **6-by-9-inch (150-by-230-mm)** sections.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **9 inches (230 mm)** long, of each color required.
- D. Samples for Verification: In manufacturer's standard size, but not less than **6-by-9-inch (150-by-230-mm)** sections of each different color and pattern of floor covering required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **9 inches (230 mm)** long, of each color required.

SECTION 09 65 36 - STATIC-CONTROL RESILIENT 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. Static-dissipative, solid vinyl floor tile

- B. Related Requirements:

- 1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with static-control resilient flooring.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

- 1. Review methods and procedures related to static-control resilient flooring
 - a. Examination and preparation of substrates to receive static-control resilient flooring.
 - b. Installation including seamless installation techniques.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include product data specific to resilient flooring adhesives for each specified product.
 - 2. With product data for each floor finish material specified, manufacturer shall provide slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.

- B. Shop Drawings: For each type of static-control resilient flooring. Include floor-covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

- 1. Submit grounding diagram showing location of grounding strips and connections.

- C. Samples for Initial Selection: For each type of static-control resilient flooring.

SECTION 09 66 23 - RESINOUS MATRIX TERRAZZO 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. Thin-set epoxy-resin terrazzo flooring and base.
- B. Related Sections:
 - 1. Division 07 Section "Joint Sealants" for sealants installed with terrazzo.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Review special terrazzo designs and patterns.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. With product data for each floor finish material specified, manufacturer shall provide slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.
- B. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work. Show layout of the following:
 - 1. Divider strips

SECTION 09 67 23 - 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. This Section includes:
 - 1. Resinous flooring systems.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants" for sealants installed at joints in resinous flooring systems
 - 2. Division 09 Section "Resinous Matrix Terrazzo Flooring" for thin-set, resinous terrazzo

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
 - 1. With product data for each floor finish material specified, manufacturer shall provide slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.
- B. Samples for Initial Selection: For each type of exposed finish required.
- C. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

SECTION 09 68 13 - TILE CARPETING

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. Modular carpet tile.
- B. Related Sections include the following:
 - 1. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles
 - 2. Carpet tile type, color, and dye lot
 - 3. Type of subfloor
 - 4. Type of installation
 - 5. Pattern of installation
 - 6. Pattern type, location, and direction
 - 7. Pile direction
 - 8. Type, color, and location of insets and borders
 - 9. Type, color, and location of edge, transition, and other accessory strips
 - 10. Transition details to other flooring materials
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: One full-size samples

SECTION 09 72 00 - WALL COVERINGS

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. Vinyl wall covering with custom image
 - 2. Flexible wall protection

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.
- C. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by **36-inch- (914-mm-)** long in size.
 - 1. Wall-Covering Sample: From same production run to be used for the Work, with specified applied. Show complete pattern repeat. Mark top and face of fabric.
- D. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by **36-inch- (914-mm-)** long in size.
 - 1. Wall-Covering Sample: From same production run to be used for the Work, Show complete pattern repeat. Mark top and face of fabric.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

SECTION 09 91 13 - 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 (Non-traffic), Concrete and Brick Masonry, Stucco, Plaster and Stone.
 - 2. Galvanized Metal.
 - 3. Galvanized Structural Steel.
 - 4. Wood, Wood Trim and Laminated Wood Columns & Beams.
- B. Related Requirements:
 - 1. Division 05 Sections "Structural Steel Framing" and "Architecturally Exposed Structural Steel Framing" for shop priming of metal substrates.
 - 2. Division 05 Section "Metal Fabrications" for shop priming metal fabrications.
 - 3. Division 05 Section "Metal Stairs and Railings" for shop priming metal floor plate stairs.
 - 4. Section 055119 "Metal Grating Stairs" for shop priming exterior metal stairs, stair railings and painting other exterior pipe and tube railings.
 - 5. Division 08 Section "Hollow Metal Doors and Frames" for shop priming of metal substrates specified in that Section.
 - 6. Division 09 Section "High-Performance Coatings" for tile-like coatings.
 - 7. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.3 DEFINITIONS

- A. MPI Gloss Levels:
 - 1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
 - 2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
 - 3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
 - 4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
 - 5. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
 - 6. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

7. 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. Step coats on Samples 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: For each product indicated, include the following:
 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.5 INFORMATIONAL SUBMITTALS

- A. Certifications
 1. Before starting work, new and existing surfaces scheduled to be painted shall be inspected by paint manufacturer's representative and certified that surfaces are compatible and in satisfactory condition to receive finish specified.
 2. Provide certification letter attesting that shop applied primers have been reviewed for compatibility and are acceptable to the topcoat manufacturers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Coating Maintenance Manual: Upon conclusion of the project, furnish a maintenance manual which shall include an area summary with finish schedule, paint color and gloss samples, where used, product data, MSDS sheets, care & cleaning instructions and touch up procedures.
- B. 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.

1.7 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation, VOC content and instructions for mixing and/or reducing.
- B. 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.
- C. Include precautionary measures to prevent fire hazards and spontaneous combustion in the approved Site-Specific Safety Manual and post in the paint storage area.

1.9 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.

1.10 WARRANTY

- A. Provide a one year written warranty from painting subcontractor covering defects in material and workmanship. Areas deemed to be defective shall be repaired as required to make the repair indiscernible.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sherwin Williams Company (SW)
 - 2. Benjamin Moore (BM)
 - 3. PPG Industries (PPG)

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: Color selections have been made from color charts published by the manufacturer(s) listed in the Finish Schedule; contractor shall match these colors without exception.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

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 (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Portland Cement Plaster: 12 percent.
 - 5. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. 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 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 reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates (Not Galvanized or Shop Primed): Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:
 - 1. SSPC-SP1 Solvent Cleaning: Remove all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces with solvent, vapor, cleaning compound, alkali, emulsifying agent, or steam prior to SSPC-SP3.
 - 2. SSPC-SP 3, Power Tool Cleaning: Remove all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by power wire brushing, power sanding, power grinding, power tool chipping, and power tool descaling.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces. Verify specified topcoat is compatible with shop primer prior to field painting. Prepare shop primed surfaces for painting per primer manufacturer's written instructions.
- 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. Prepare galvanized surfaces for painting per primer manufacturer's written instructions.
 - 1. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
- I. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
- J. Existing Surfaces: Where existing painted surfaces are scheduled to be painted, prepare as follows:
 - 1. Remove dirt, mold, mildew and other contaminates per manufacturer's instructions.
 - 2. Lightly sand entire surface to be painted.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable 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. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint 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. Galvanized exterior items and miscellaneous fabrications to be field painted include, but are not limited to, the following:
1. Exposed steel stair work
 2. Steel hand railings and supports
 3. Exterior metal doors and frames.
 4. Exterior steel channel jambs
 5. Steel bollards
 6. Chain link and wire mesh partitions.
 7. Ladders
 8. Exposed primed metal without a finish coat.
- F. Paint exposed galvanized structural steel and dunnage scheduled for painting.
- G. 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.
 - 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.
 - h. Duct, equipment, and pipe insulation or other paintable jacket material.
 - i. Other items as indicated.
 2. Color banding and identification (flow arrows, naming, numbering, etc.) are provided by the Division 21, 22, 23, 25, 26, 27 and 28 Contractors.
 3. Do not paint or in any way obscure certification or identification labels on any material or equipment.

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: The paragraphs below cover a range of painting systems. The Contractor shall consult drawings for paint location, type, gloss and color to be applied to each individual substrate. Not all scheduled systems will be included on the drawings. Where the product line permits, provide products from a sole source single manufacturer.

- A. Concrete (Non-traffic), Concrete and Brick Masonry, Stucco, Plaster and Stone.
1. Latex System; Flat (Gloss Level 1)
 - a. 1 Coat Primer: water borne emulsion type primer for exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Loxon Concrete and Masonry Primer and Sealer
 - b) BM Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer 608
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer
 - b. 2 Coats Topcoat: Latex, exterior, institutional low odor/VOC, Flat.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Flat

- b) BM Ultra Spec EXT Flat Finish N447
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Flat
- 2. Existing Painted Surfaces:
 - a. Apply one coat low VOC primer product as recommended by the manufacturer compatible with painted substrate and specified topcoat.
 - b. Apply two coats specified topcoat.
- 3. Elastomeric System – Flat/Satin
 - a. Prepare substrate per manufacturers written instructions.
 - b. 2 Coats Topcoat: Elastomeric high build; applied 6 mils dft per coat.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Loxon XP Waterproofer
 - b) BM Ultra Spec Masonry Elastomeric Waterproofing Coating, Flat 359, Low Lustre
- 4. High Build 100% Acrylic Topcoat
 - a. Surfaces to be coated must be dry, clean, sound, and free from all contamination including loose and peeling paint, dirt, grease, oil, wax, concrete curing agents and bond breakers, chalk, efflorescence, mildew, rust, product fines, and dust. Remove loose paint, chalk, and efflorescence by wire brushing, scraping, sanding, and/or pressure washing. Clean surfaces per ASTM Standard Practice D4258-83: Standard Practice for Surface Cleaning Concrete for Coating.
 - b. Dry substrate thoroughly to a moisture content under 12%.
 - c. Apply per manufacturer’s written instructions.
 - d. Acceptable Product: Subject to compliance with requirements, provide one of the following:
 - 1) (1) coat Primer:
 - a) SW Loxon Concrete and Masonry Primer and Sealer.
 - b) BM Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer 608
 - c) PPG Architectural Coatings 4-22 Perma-Crete LTC (Low Temperature Cure) Concrete Block & Masonry Surfacer/Filler.
 - 2) (2) coats Topcoat:
 - a) SW Conflex UltraCrete Acrylic Textured Masonry Topcoat A44W800 Series
 - b) BM Coronado Texcrete WB Masonry Waterproofer Smooth Finish 3194
 - c) PPG Architectural Coatings 4-22 Perma-Crete High Build 100% Acrylic Topcoat.
- 5. High Build Coating: Solvent Acrylic Exterior Waterproof and Textured Coating, applied 20 mils dft.

- a. Prepare substrate as directed by the structural engineer of record.
 - b. 2 Coat application: 10 mils dft ea. coat (20 mils dft min. total)
 - 1) SW Conflex UltraCrete Solvent Borne Texture Coating
- B. Galvanized Metal Fabrications: Including but not limited to, steel control panels, handrails, ornamental iron, steel lintels, steel fences and chain link, steel fire escapes and stairs, steel ladders and cross-overs, steel pipes and downspouts, steel gutters, steel catwalks, steel posts and bollards, hollow metal doors and frames and steel window sash.
- 1. Latex System; Gloss
 - a. 1 Coat Primer: Water based, anti-corrosive pigments and acrylic resins, for cleaned/etched galvanized metal.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Pro Industrial Pro-Cryl Universal Primer
 - b) BM Ultra Spec HP Acrylic Metal Primer HP04
 - c) PPG Architectural Coatings Pitt-Tech Plus Exterior DTM Industrial Primer.
 - b. 2 Coats Topcoat: Latex, exterior, institutional low odor/VOC, Gloss.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Pro Industrial DTM Acrylic
 - b) BM Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP 29, Gloss HP28
 - c) PPG Architectural Coatings Pitt-Tech Plus Exterior DTM Industrial Enamel.
- C. Galvanized, Non-Ferrous and Ferrous Structural Steel: Exposed structural steel, steel dunnage and steel equipment supports.
- 1. High Performance System: High Build; Semi-Gloss
 - a. 1 Coat Epoxy: Water Borne Emulsion Type Primer for Exterior Surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Protective and Marine Macropoxy 646-100 Fast Cure Epoxy (7 mil dft minimum)
 - b) BM Corotech Surface Tolerant Epoxy Mastic (V160) (7 mil dft minimum).
 - b. 2 Coats Aliphatic Urethane, Semi-gloss.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:

- a) SW Acrolon Ultra, Semi-Gloss (4 mils dft minimum).
 - b) BM Corotech Aliphatic Urethane Semi-gloss V510 (4 mil dft minimum)
- D. Wood Items: (Fences, siding, joists, plywood, partitions, underside decking, etc., other than wood trim)
- 1. Latex System: Flat (Gloss Level 1-2)
 - a. 1 Coat Primer: Water based, wood primer for exterior wood surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Exterior Latex Wood Primer
 - b) BM Ultra Spec Exterior Latex Primer N558
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer.
 - b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Flat
 - b) BM Ultra Spec Latex Exterior Flat N447
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Flat
 - 2. Latex System: Satin (Gloss Level 3-4)
 - a. 1 Coat Primer: Water based, wood primer for exterior wood surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Satin
 - b) BM Ultra Spec Exterior Latex Primer N558
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Satin
 - b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Satin
 - b) BM Ultra Spec EXT Satin Finish N448
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Satin
 - 3. Stain Finish: Penetrating alkyd stain (Semi-Transparent)
 - a. 2 coats stain: Water Based, Emulsion Type, Pigmented Stain for Primed Exterior Wood Surfaces
 - 1) SW Woodscapes Exterior Acrylic Semi-Transparent Stain

- 2) BM Arborcoat Alkyd Semi-Transparent Stain 328
- 3) PPG Sun Proof Deck, Fence & Siding Alkyd/Oil Semi-Opaque Stain.

E. Wood Trim (Doors, Door Frame, Window Sash and Frames, Fascia, Batten, etc.)

1. Latex System: Semi-Gloss (Gloss Level 5)

- a. 1 Coat Primer: Water based, wood primer for exterior wood surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Exterior Latex Wood Primer
 - b) BM Ultra Spec EXT Latex Primer N558
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer.
- b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Semi-Gloss
 - b) BM Ultra Spec EXT satin N448, gloss N449
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Semi-Gloss

2. Stain Finish: Penetrating alkyd stain (Semi-Transparent)

- a. 2 coats stain: Water Based, Emulsion Type, Pigmented Stain for Primed Exterior Wood Surfaces
 - 1) SW Woodscapes Exterior Acrylic Semi-Transparent Stain
 - 2) BM Arborcoat Alkyd Semi-Transparent Stain 328
 - 3) PPG Sun Proof Deck, Fence & Siding Alkyd/Oil Semi-Opaque Stain.

F. Exterior Glue Laminated Beams and Columns

1. Latex System: Flat (Gloss Level 1-2)

- a. 1 Coat Primer: Water based, wood primer for exterior wood surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Exterior Latex Wood Primer
 - b) BM Ultra Spec EXT Latex Primer N558
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer.
- b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:

- a) SW A-100 Exterior Latex Flat
 - b) BM Ultra Spec EXT Latex Flat N447
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Flat

- 2. Latex System: Satin (Gloss Level 3-4)
 - a. 1 Coat Primer: Water based, wood primer for exterior wood surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Exterior Latex Wood Primer
 - b) BM Ultra Spec EXT Latex Primer N558
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer.

 - b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Satin
 - b) BM Ultra Spec EXT Satin Finish N448
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Satin

- 3. Latex System: Semi-Gloss (Gloss Level 5)
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW Exterior Latex Wood Primer
 - b) BM Ultra Spec EXT Latex Primer N558
 - c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer.

 - b. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.
 - 1) Acceptable Product: Subject to compliance with requirements, provide the following:
 - a) SW A-100 Exterior Latex Semi-Gloss
 - b) BM Ultra Spec EXT Low Lustre N455 Satin N448, Gloss N449
 - c) PPG Architectural Coatings Sun-Proof Exterior Latex Semi-Gloss

- 4. Stain Finish: Penetrating Acrylic stain (Semi-Transparent)
 - a. 2 coats stain: Water Based, Emulsion Type, Pigmented Stain for Primed Exterior Wood Surfaces
 - 1) SW Woodscapes Exterior Acrylic Semi-Transparent Stain
 - 2) BM Arborcoat Waterborne Semi-Transparent Stain N638

END OF SECTION 09 91 13

SECTION 09 91 23 - 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 paint systems on the following interior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Ferrous metal.
4. Galvanized metal.
5. Gypsum board.
6. Plaster.
7. Wood.

- B. Related Requirements:

1. Division 05 Sections "Structural Steel Framing," "Architecturally Exposed Structural Steel Framing" and "Steel Decking" for shop priming of metal substrates with primers specified in that Section.
2. Division 05 Section "Metal Fabrications" for shop priming metal fabrications.
3. Division 05 Section "Metal Stairs and Railings" for shop priming metal stairs and railings and other interior pipe railings.
4. Division 06 Sections "Finished Carpentry" and "Architectural Cabinets" for transparent finishes for woodwork and millwork.
5. Division 08 Section "Hollow Metal Doors and Frames" for shop priming of metal substrates with primers specified in that Section.
6. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 DEFINITIONS

- A. MPI Gloss Levels:

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

SECTION 10 14 19 - DIMENSIONAL LETTER 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. Cast dimensional characters.
 - 2. Cutout dimensional characters.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."

1.4 DEFINITIONS

- A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.5 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For 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, typestyles, graphic elements, and layout for each sign at least 3/4" = 1'-0" scale.
 - 4. Show locations of electrical service connections.
 - 5. Include diagrams for power, signal, and control wiring.

SECTION 10 14 23.13 - ROOM-IDENTIFICATION 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 room-identification signs that are directly attached to the building.
- B. Related Requirements:
 - 1. Owner's Campus Interior Signage Standards

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.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification 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 others, and accessories.
 - 3. Show message list, tpestyles, 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 tpestyles and graphic symbols.

SECTION 10 21 13 - TOILET COMPARTMENTS

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 phenolic-core units as follows:
 - 1. Toilet Enclosures
 - 2. Urinal Screens
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" for blocking.
 - 2. Division 09 Section "Gypsum Board Systems" for blocking.
 - 3. Division 10 "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For toilet compartments.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show locations of cutouts for compartment-mounted toilet accessories.
 - 3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
 - 4. Show locations of centerlines of toilet fixtures.
 - 5. Show locations of floor drains.
 - 6. Show ceiling grid, ceiling-mounted items, and overhead support or bracing locations.
- C. Samples for Initial Selection: For each type of toilet compartment material indicated.
 - 1. Include Samples of hardware and accessories involving material and color selection.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

SECTION 10 26 00 - 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. This Section includes the following:
 - 1. Corner guards.
 - 2. End-wall guards.
 - 3. Abuse-resistant wall coverings.

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 for each impact-resistant wall-protection unit.
 - 2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.
- B. Shop Drawings: For each type of wall and door protection showing locations and extent.
- 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. Corner and End-Wall Guards: 12 inches (300 mm) long. Include example top caps.
 - 2. Abuse-Resistant Wall Covering: 6 by 6 inches (150 by 150 mm) square.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installer.
- B. Material Test Reports: For each impact-resistant plastic material.
- C. Material Certificates: For each impact-resistant plastic material, signed by manufacturer.

SECTION 10 28 00 - TOILET AND BATH 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. This Section includes the following:
 - 1. Washroom accessories.
 - 2. Shower room accessories, including curtains.
 - 3. Custodial accessories.
 - 4. Under-Lavatory guards.
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" and Division 09 Section "Gypsum Board Systems" for wood and metal blocking installed to support toilet accessories.
 - 2. Division 08 Section "Mirrors" for frameless mirrors

1.3 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.
- C. Contractor shall be responsible to coordinate blocking requirements for all accessory items, including changing stations, grab bars and shower seat with specific requirements noted in Division 06 Section "Miscellaneous Rough Carpentry" and Division 09 Section "Gypsum Board Systems"

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.

SECTION 10 44 13 - FIRE EXTINGUISHERS AND 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:
 - a. Portable fire extinguishers
- 2. Hand carried fire extinguishers.

- B. Related Requirements:

- 1. Division 21 Section "Fire-Suppression Standpipes" for fire-hose connections.

1.3 PREINSTALLATION CONFERENCE

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

- 1. Review methods and procedures related to fire-protection cabinets including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- 1. Fire Protection Cabinets: 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. Include rating and classification.
- 2. Fire Extinguishers: Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

SECTION 10 56 13 - METAL STORAGE SHELVING

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. Case-type metal storage shelving.
 - 2. Four-post metal storage shelving.
 - 3. Post-and-beam metal storage shelving.
- B. Related Sections include the following:
 - 1. Division 11 Section "Library Stack Systems" for library shelving systems including cantilever-bracket shelving supported by wall-mounted standards.
 - 2. Division 12 casework sections for cantilever-bracket shelving supported by wall-mounted standards

1.3 COORDINATION

- A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.
- B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at location determined by Construction Manager and coordinated with Owner.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

SECTION 11 30 13 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cooking appliances.
 - 2. Refrigeration appliances.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Fixtures" for kitchen sinks, waste disposers, and instant hot-water dispensers

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturers' special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

SECTION 11 48 10 - FIELD WALL PADS

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. Section Includes:
 - 1. Vinyl covered pads backed with plywood
 - 2. Railing pads
 - 3. Padding for wire mesh and chain link fence post and top rails
 - 4. Padding for chain link fencing infill.
- B. Related Requirements:
 - 1. Division 32 Section "Chain Link Fences and Gates"

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For field wall pad components
- B. Shop Drawings:
 - 1. For pad construction, indicating design thickness, all attachment details, and layout elevations. Indicate field verified dimensions.
- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of vinyl padding cover.
- D. Samples for Verification: Sample of finished products for representative application.
 - 1. Size: Minimum 12" square for wall pads; minimum 12" long for pipe/rail pads.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For padding systems, including safety inspection checklists.
- B. Warranty Documentation:
 - 1. Manufacturers' special warranties effective from Final Acceptance.

2. Installer's special warranties effective from Final Acceptance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Wall Pads: Full-size units equal to 10 percent of quantity installed for each size indicated, but no fewer than 2 units.
 2. Railing Pads: Full-size units equal to 5 percent of quantity installed for each size indicated, but no fewer than 20 lineal feet.
- B. Schedule of maintenance material items.

1.6 DELIVERY, STORAGE, AND HANDLING

1.7 FIELD CONDITIONS

1.8 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace components of installed padding that fail(s) in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including delamination of materials.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 2 year(s) from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements of this section, provide products from one of the following:
 1. Turbolink International; (800) 958-8726
 2. SportsField Specialties; (888) 975-3343
 3. Beacon Athletics; (800) 747-5985

2.2 SOURCE LIMITATIONS

- A. Obtain Padding from single manufacturer.

2.3 MATERIALS

- A. Vinyl Covering: 18 oz. per square yard laminated polyester vinyl, unbalanced coating - 10 mils top - 4 mils bottom. 1000 denier, Tear Strength test: Warp 85 lbs., Fill 83 lbs., Tensile Strength: Warp 221 lbs., Fill 216 lbs., 9 x 9 weft insertions, Cold Crack - 20 degrees F, Class A flame retardant. UV inhibitors. Color to be selected from manufacturer's standard selection. Each pad shall have 3 weep holes to evaluate moisture.
- B. Filler Foam: 3-inch thick Polyurethane Foam Density, 1.5 - 1.7 lbs/cubic foot, Indention Load Deflection: 87.0 - 93.0 °25% (4 inch), Tear Strength 1.20 PLI Min, Tensile Strength 15.0 PSI Min, elongation 75-125% Mi. Passes flammability specifications for California T.B. 117 and NFPA 260, 1989.
- C. Filler foam for chain link fence, fence posts, and fence top rail pads: 3 inch thick polyurethane open cell foam, 1.5 to 1.6 lbs./cubic foot density.
- D. Filler foam for guardrail and handrail pads: 1 inch thick polyurethane open cell foam, 1.9 lbs. cubic foot density.
- E. Plywood: 3/4 inch APA BC exterior grade plywood or better. Painted on both sides to match vinyl color.
- F. Attachments:
 - 1. Plywood Back Wall: "Z" clip: Aluminum extrusion, 2.5 inch x .125 inch thickness, mounted to panel using 1/4 inch x 1 inch stainless steel bolts screwed into 1/4 inch threaded washer inserts.
 - 2. Post Pads: 2-inch vinyl flap with #3 grommets every 12 inches o.c. on sides of the pad. Lace to post with 1/4-inch black nylon lacing.
- G. UV-resistant, weather-treated, corrugated polyurethane.

2.4 MANUFACTURED UNITS

- A. Field Wall Pads: Provide units with vinyl covering stretched over filler foam and attached to back of plywood panel. Mount to wall with "Z" clips or other non-corrosive hardware to be readily removable.
- B. Guard and Hand Railing Pads: Covered filler foam with vinyl fabric. Provide #3 brass grommets spaced 6 inches on center for lacing to rail.
- C. Chain Link Fence, Fence Posts, and Fence Top Rail Pads: For top rail provide units similar to railing pads application. For fence post provide 6-inch wide flat units with brass grommets spaced 6 inches on center. Both pads shall be laced to fence.
- D. Chain Link Fence Infill Pads: Provide units similar to field wall pad application. Provide units with brass grommets spaced 6 inches on center. Pad shall be laced to fence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Reject fabricated units that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install per manufacturer's recommendations and approved shop drawings. Joints between field wall pads shall be level and plumb and tightly aligned with adjacent pads.

END OF SECTION 11 48 10

SECTION 11 66 23 – RETRACTABLE BATTING CAGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vertically retracting interior batting cages.
2. Related support materials.

B. Related Requirements:

1. Division 05 section “Architecturally Exposed Structural Steel” for steel finish requirements for secondary framing.
2. Division 26 sections "Common Materials and Methods for Electrical" and “Low-Voltage Electrical Power Conductors and Cables” for powering lifting motors and key switches.

1.02 DEFINITIONS

- A. Fully Enclosed: Batting tunnels contained by four net walls and an overhead net barrier

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at location coordinated with Owner.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Batting tunnel

B. Shop Drawings:

1. For batting tunnel and mounting system
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Verification: Actual sample of finished products for netting.

1. Size: 12 inches (30 cm) square, minimum.

D. Delegated Design Submittals: For batting tunnels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

SECTION 12 24 13 – ROLLER WINDOW SHADES

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. Manually operated roller shades with single rollers.
- 2. Motor-operated roller shades with single rollers.

- B. Related Sections include the following:

- 1. Division 05 Section "Metal Fabrications" for custom metal pockets for window treatments fabricated from metal extrusions.
- 2. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for mounting roller shades and accessories.
- 3. Division 09 Section "Gypsum Board Systems" for wood blocking for mounting roller shades and accessories.
- 4. Division 26 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized shade operation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

- 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

- C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

SECTION 14 42 00 - WHEELCHAIR LIFTS

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. Vertical platform lifts.

- B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 2. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry.
 - 3. Section 087100 "Door Hardware" for runway-enclosure door hardware including monitored, electric door strikes if not included in lift work.
 - 4. Section 099123 "Interior Painting" for field painting of lift equipment.

1.3 DEFINITIONS

- A. Definitions in ASME A18.1 apply to Work of this Section.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.

- B. Shop Drawings: For each lift.

- 1. Include plans, elevations, sections, attachment details, and required clearances.
 - 2. Indicate dimensions, weights, loads, and points of load to building structure.
 - 3. Include details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.



NC State University

Doak Field Enhancements

1081 VARSITY DR | RALEIGH | NORTH CAROLINA 27606

Project Manual – Volume 2 (Divisions 21-33) Construction Documents

SCO CONTRACT NUMBER: 22-24384-01A
NC STATE PROJECT NUMBER: 202120015
EWINGCOLE PROJECT NUMBER: 20220400

January 29, 2024

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26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	•
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	•
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	•
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS	•
26 05 43	UNDERGROUND DUCTS AND STRUCTURES FOR ELECTRICAL SYSTEMS	•
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS	•
26 05 73	ELECTRICAL SYSTEMS STUDIES AND ANALYSIS	•
26 09 23	LIGHTING CONTROL DEVICES	•
26 09 36	MODULAR DIMMING CONTROLS	•
26 22 00	LOW-VOLTAGE TRANSFORMERS	•
26 24 16	PANELBOARDS	•

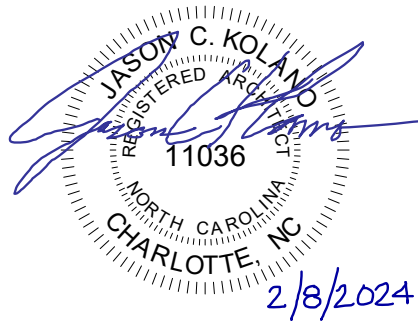
Section Number	Section Name	CONSTRUCTION DOCUMENTS - JANUARY 29, 2024
26 27 26	WIRING DEVICES	•
26 28 13	FUSES	•
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	•
26 29 13	ENCLOSED CONTROLLERS	•
26 43 13	SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS	•
26 51 00	INTERIOR LIGHTING	•
26 56 00	EXTERIOR LIGHTING	•
DIVISION 27 - COMMUNICATIONS		
27 10 00	STRUCTURED CABLING SYSTEM	•
27 41 16	INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT	•
27 41 16.1	BOWL SOUND SYSTEM	•
DIVISION 28 - ELECTRONIC SAFETY AND SECURITY		
28 05 00	COMMON MATERIALS AND METHODS FOR ELECTRONIC SAFETY AND SECURITY	•
28 05 13	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY	•
28 31 11	DIGITAL, ADDRESSABLE FIRE-DETECTION AND ALARM SYSTEM	•
DIVISION 31 - EARTHWORK		
31 10 00	SITE CLEARING	•
31 20 00	EARTH MOVING	•
31 23 17	TRENCHING	•
31 23 19	DEWATERING	•
31 23 24	FLOWABLE FILL	•
31 25 00	EROSION AND SEDIMENTATION CONTROL	•
DIVISION 32 - EXTERIOR IMPROVEMENTS		
32 18 13	SYNTHETIC TURF SURFACING	
DIVISION 33 - UTILITIES		
33 11 00	WATER UTILITY DISTRIBUTION SYSTEMS	•
33 30 00	SANITARY SEWER UTILITY DISTRIBUTION SYSTEM	•
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DOCUMENT 00 01 07 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. EwingCole
2. Jason C. Kolano
3. 11036 (North Carolina)
4. Responsible for Division 00-49 and referenced drawings in Construction Documents issuance, except where indicated as prepared by other design professionals of record.



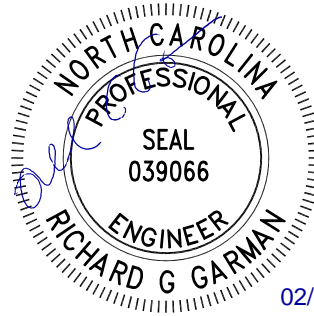
B. Civil/Landscape Engineer:

1. McAdams
2. James Eason
3. 042597 (North Carolina)
4. Responsible for sections:
 - a. 02 41 13 Selective Site Removal
 - b. 32 10 00 Site Clearing
 - c. 31 20 00 Earth Moving
 - d. 31 23 17 Trenching
 - e. 31 23 19 Dewatering
 - f. 31 23 24 Flowable Fill
 - g. 31 25 00 Erosion and Sedimentation Control
 - h. 33 11 00 Water Utility Drainage Piping
 - i. 33 30 00 Sanitary Sewer Utility Distribution System
 - j. 33 41 00 Storm Utility Drainage Piping
 - k. 33 49 13 Storm Drainage Structures



C. Electrical Engineer:

1. Ewing Cole
2. Richard Garman
3. 039066 (North Carolina)
4. Responsible for:
 - a. Division 26 Sections
 - b. Section 28 31 11 "Digital, Addressable Fire Detection and Alarm System"



02/07/2024

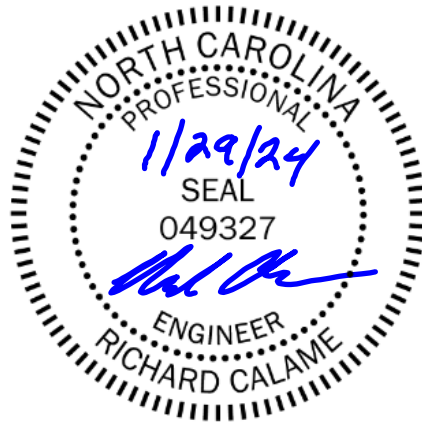
D. Mechanical Engineer:

1. EwingCole
2. Richard Calame
3. 049327 (North Carolina)
4. Responsible for Division 23



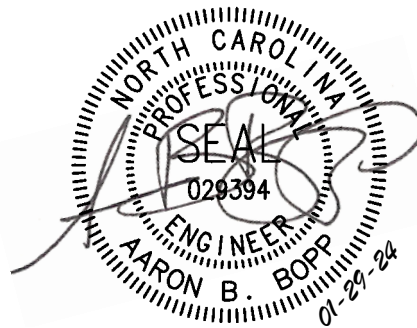
E. Plumbing Engineer:

1. EwingCole
2. Richard Calame
3. 049327 (North Carolina)
4. Responsible for Division 22



F. Structural Engineer:

1. SKA Consulting Engineers
2. Aaron B. Bopp
3. 029394 (North Carolina)
4. Responsible for Sections:
 - a. 01 41 00 Special Inspections
 - b. 01 41 01 Statement of Special Inspections
 - c. 03 10 00 Concrete Formwork
 - d. 03 20 00 Concrete Reinforcement
 - e. 03 25 00 Adhesive Anchors
 - f. 03 30 00 Cast in Place Concrete
 - g. 05 12 00 Structural Steel
 - h. 05 31 00 Steel Decking



G. Low Voltage:

1. WHJW
2. Todd Semple
- 3.
4. Responsible for: Divisions 27 and 28.

END OF DOCUMENT 00 01 07

SECTION 21 00 00 - FIRE SUPPRESSION

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 is intended to describe the fire protection equipment and devices for the fire suppression work.

- B. This section includes the following:

1. Applicable requirements of Section 22 05 00, Basic Materials and Methods.
2. Wet standpipe system, Class 2, including pipe, and fire department valve.
3. Wet sprinkler system, including piping, alarm valve, sprinkler heads, valves, accessories.
4. Through-penetration fire-stop systems at penetrations through floors and fire or smoke rated walls or partitions will be provided by Contractor for Division 07. Refer to Section 22 05 00 for work in this section.
5. Miscellaneous fire protection accessories.

- C. Related sections include the following:

1. All applicable sections of Division 1
2. Division 7: Sealants
3. Section 22 05 00: Basic Materials and Equipment
4. Section 22 05 13: Electrical Requirements for Plumbing Equipment

1.3 REFERENCES AND REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

- A. Codes and Standards: The fire protection equipment and installation shall conform to the requirements of all applicable codes, rules, regulations and standards, including, but not limited to, the following:

1. Maine Uniform Building & Energy Code (MUBEC) Based on the International Building Code, 2015 edition
2. NFPA 1 – Fire Code
3. NFPA 13 - Standard for the Installation of Sprinkler Systems
4. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems
5. NFPA 25 - Standard for the Inspection, Testing and Maintenance of Water-Based Fire

Protection Systems

6. NFPA 30 - Flammable and Combustible Liquids Code
7. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals
8. NFPA 70 - National Electrical Code
9. NFPA 72 - National Fire Alarm Code
10. NFPA 101 - Life Safety Code

- B. NEMA MG-1: Motors and Generators
- C. NEMA ICS-6: Enclosures for Industrial Control and Systems
- D. NICET: National Institute for Certification in Engineering Technologies

1.4 SUBMITTALS

- A. Provide submittals in accordance with Article 2.1 of this section and in accordance with Section 01 33 00, Submittal Procedures, in sufficient detail to verify full compliance with the requirements of the contract documents.
- B. Before starting work, submit Contractor's documentation as specified in the Quality Assurance article of this section.
- C. Submit data sheets for all products listed in this section. Where data sheets include information on multiple sizes or types of materials, clearly indicate which item is being submitted for review.
- D. Submit reflected ceiling plans showing proposed location of sprinkler heads, with respect to ceiling lights, diffusers, ceiling grid framing members, etc. Be responsible for verifying that spacing of heads located near surface mounted and/or suspended lighting fixtures, HVAC diffusers and any other obstruction complies with applicable NFPA requirements.
- E. Sprinklers shall be referred to on drawings and other documentation by the manufacturer's model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations are not permitted.
- F. After review of reflected ceiling plan, prepare working plans of installation. Include size of all piping, method of anchoring and hanging pipe, location and type of valves, position, type and temperature ratings of sprinkler heads, material and equipment list indicating manufacturers' names and types, structural, mechanical, electrical and architectural coordinating information, and the various other items pertinent to the complete installation of the systems. Indicate seismic restraint locations and details when seismic restraint requirements are specified.
- G. Working plans shall comply with the requirements of applicable NFPA standard, shall be prepared at a scale of not less than 1/8" = 1'-0" and shall bear either the seal of a registered professional engineer experienced in fire protection system design or copy of NICET certification for the responsible design professional prior to submission to authority having jurisdiction. Designer NICET or professional engineering qualifications must meet or exceed the requirements of the Authority Having Jurisdiction.

1. National Fire Protection Association
 2. The Factory Mutual Engineering Division
 3. Local and State codes and regulations.
 4. Utility company providing the electrical service.
- C. Manufacturers: All products and materials utilized in the fire protection systems shall be listed for fire protection service by Underwriters' Laboratories (UL) and approved for fire protection service by Factory Mutual (FM). Factory Mutual approval is required when the Factory Mutual Engineering Division is included in the paragraph above.
1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 2. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
- D. Contractor
1. The Fire Protection Contractor for the fire protection system shall be qualified for the work specified herein, regularly engaged in the installation of automatic fire suppression systems and equipment.
 2. The Fire Protection Contractor shall have a minimum of five years' experience in the installation of fire suppression systems. Upon request, documentation shall be submitted to show that the Fire Protection Contractor has provided similar systems to those specified herein. Documentation on at least 3 similar systems shall be provided including the system size and the name of a contact person at the facility.
 3. Documentation shall be provided to show that all fire protection system(s) is designed by an employee with a Level III or Level IV NICET (National Institute for Certification in Engineering Technologies) certification in automatic fire suppression system layout. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of the designer.

1.8 DESIGN BASIS

- A. Drawings indicate areas to be protected by Fire Protection Systems and show location of main water supply and risers. Drawings are diagrammatic and not necessarily complete, and work is not limited to that shown. Design, arrangement, size and location of risers, feed mains, cross mains, branch lines and drains and spacing, number and types of heads must conform with requirements of Authorities, Standards, and Codes for the hazards and applicable occupancies.
- B. Number and Location of Sprinkler Heads
1. Where head location is not shown on the drawings, provide coordinated layout with the ceiling plan. Locate heads in the center of ceiling tiles.
 2. Where head locations are shown on the drawings, provide at the locations shown as a minimum. If additional heads are required to conform to requirements of authorities,

standards and codes for the hazard and application, coordinate head layout with Architect before preparing submittals.

3. Provide all additional sprinklers required for a complete sprinkler system installation in compliance with NFPA 13. Additional sprinklers in excess of quantities indicated on drawings shall be provided at no additional cost when required to comply with NFPA 13 (13R) obstruction, location and spacing requirements.

C. Sprinkler system shall be hydraulically designed in accordance with the following criteria:

1. All laboratories, mechanical rooms, electrical equipment storage rooms and similar areas:
 - a. Minimum design density of 0.20 gpm per square foot over the hydraulically most remote 2500 square feet.
 - b. Maximum protection area per sprinkler of 130 square feet.
 - c. Outside hose stream demand of 250 gpm
 - d. Minimum sprinkler k-factor of 8.0
2. All office areas, corridors and similar light hazard areas.
 - a. Minimum design density of 0.10 gpm per square foot over the hydraulically most remote 1500 square feet.
 - b. Maximum protection area per sprinkler of 225 square feet.
 - c. Outside hose stream demand of 250 gpm
 - d. Minimum sprinkler k-factor of 5.6
3. BSL-3 Laboratory
 - a. Minimum design density of 0.20 gpm per square foot over the hydraulically most remote 3000 square feet.
 - b. Maximum protection area per sprinkler of 130 square feet.
 - c. Outside hose stream demand of 250 gpm
 - d. Minimum sprinkler k-factor of 8.0
4. Loading Dock & Chemical Storage Room
 - a. Minimum design density of 0.30 gpm per square foot over the hydraulically most remote 2500 square feet.
 - b. Maximum protection area per sprinkler of 100 square feet.
 - c. Outside hose stream demand of 500 gpm
 - d. Minimum sprinkler k-factor of 11.2
5. Warehouse: Shelf/palletized storage of Group A uncartoned, unexpanded plastics
 - a. 12 sprinklers operating at 26 psi
 - b. Maximum protection area per sprinkler of 100 square feet.
 - c. Outside hose stream demand of 250 gpm
 - d. Minimum sprinkler k-factor of 14.0
6. Cold Storage: Shelf/palletized storage of Group A uncartoned, unexpanded plastics

- a. 12 sprinklers operating at 26 psi
 - b. Maximum protection area per sprinkler of 100 square feet.
 - c. Outside hose stream demand of 250 gpm
 - d. Minimum sprinkler k-factor of 14.0 (dry pendent)
- D. Include a total hose stream demand of 500 gpm in the hydraulic calculations, including inside and outside hose.
- E. For purposes of bidding, the contractor shall use the following water supply:
- | <u>Flow, gpm</u> | <u>Pressure, psi</u> |
|-----------------------------------------------------------------------------------------|----------------------|
| 0 | 80 |
| 1433 | 75 |
| Test Hydrant: SPD-HYD00470
Flow Hydrant: SPD-HYD00477
Both are along Gannet Drive | |
- F. The contractor shall perform or have the water authority perform an additional flow test prior to the system design. In any case, where multiple water supply curves are available, the contractor shall use the lowest available normal operation curve as the basis of design.
- G. Sprinkler system water velocity shall not exceed 20 feet per second.
- H. The combined sprinkler and hose stream system demand pressure shall include at minimum ten (10) psig safety factor.
- I. Where there is a conflict between the drawings or specifications and any referenced standard, include the item of greater cost in the work and bring such conflict to the attention of the Architect for resolution.

1.9 INSPECTIONS

- A. Arrange and pay for all inspections, approvals, examinations and tests required by authorities having jurisdiction as necessary to obtain complete and final acceptance of Fire Protection Systems. Deliver certificates of all such inspections, approvals and tests to Architect and Owner's representative after completion of the installation.

1.10 TESTS

- A. Test fire protection systems as specified in 22 05 00, Basic Materials and Methods, as specified in Part 3 of this section, and as required by applicable NFPA reference standard. Conduct tests in presence of a representative of the fire insurance rating organization. Pay expenses in connection with performing tests.

1.11 INSPECTION SERVICE

- A. After completion of work and at the start of the warranty year, execute an "Inspection Agreement" with the Owner without additional cost to the Owner that includes provision of inspection, testing and maintenance of all fire protection equipment in accordance with the quarterly requirements of NFPA 25 and/or other appropriate reference standards. The agreement shall cover four site visits by the contractor scheduled on a quarterly basis as agreed by the Owner.
- B. After each inspection, submit to the Owner, insurance carrier and authority having jurisdiction as directed by the Owner, a "Report of Inspection" on a standard form similar to those provided in Appendix B of NFPA 25.

1.12 SEISMIC DESIGN

- A. Coordinate ceiling penetrations with ceiling installer to provide minimum clearance requirements around sprinkler penetration per seismic requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of the following manufacture:
 - 1. Alarm Bell
 - a. Potter Electric Signal Co.
 - b. System Sensor
 - 2. Backflow Preventer (Double Check)
 - a. Ames
 - b. Watts
 - c. Zurn
 - 3. Fire Department Connections
 - a. Allenco
 - b. Elkhart Brass Mfg. Co.
 - c. Potter-Roemer, Inc.
 - d. Croker
 - 4. Fire Extinguisher
 - a. Ansul
 - b. Kidde, Inc.
 - c. Fyr-Fyter

5. Fire Protection System Valves, Type FPSV
 - a. Crane
 - b. Tyco Fire and Building Products
 - c. Kennedy
 - d. Milwaukee
 - e. Mueller Co.
 - f. Stockham
 - g. Victaulic Company of America
 - h. Anvil
 - i. Nibco

6. Monitor, Switches
 - a. Notifier
 - b. Potter Electric Signal Co.

7. Pipe and Fitting Materials
 - a. General: Unless otherwise specified, any United States manufacturer whose products comply with the reference standards. Submittals are not required where a manufacturer is not specified.
 - b. Basic Piping and Fitting Materials and Accessories not Specified in this Section: Refer to Section 22 05 00 and NFPA references.

8. Sprinkler Heads
 - a. Tyco Fire and Building Products
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. The Viking Corporation
 - d. Flexhead
 - e. Victaulic Company of America

9. Sprinkler Valve Assemblies (Wet)
 - a. Tyco Fire and Building Products
 - b. Victaulic Company of America
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. The Viking Corporation

10. Water Flow Switches
 - a. Potter Electric Signal Co.
 - b. Notifier
 - c. System Sensor

2.2 ALARM BELL

- A. Six inch, single stroke underdome type with red enamel finish. In the absence of accessible ceiling in finished area, install bell in flush wall box having front removable ornamental grille.

2.3 BACKFLOW PREVENTER DOUBLE CHECK

- A. Complete factory assembly consisting of two check valves with UL/FM resilient seated outside screw and yoke gate valves before and after check valves and bronze ball valve test cocks. Strainer not to be included.
- B. Check valves 3 inches in size and smaller, bronze body with bronze seats and trim. Check valves 4 inches and larger in size, epoxy coated inside and out cast iron body with bronze seats and trim. Check valve assemblies may be Type 304 Schedule 40 stainless steel housing with grooved ends and stainless steel torsion spring check valves with elastomer discs for maximum working pressure of 175 psig.
- C. Working pressure 175 psig at 110° F continuous, Class 125 flanged ends.
- D. Comply with all applicable local codes.

2.4 FIRE DEPARTMENT INLET CONNECTIONS

- A. Fire department inlet connections shall be UL listed and FM approved two-way projecting type, Potter-Roemer or approved equal. Unit shall be (polished chrome plated) (polished brass) Potter-Roemer, #5710 2-1/2 inch x 2-1/2 inch x 4 inches. Escutcheon shall be labeled AUTO SPKR. Unit shall have swing clapper, plugs and chains. Threaded hose connections shall conform to local fire department requirements.
- B. All fire department inlet connections shall be equipped with an automatic ball drip installed between connection and check valve. Pipe ball drip discharge to grade or to drain.
- C. At the low point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Basis of Design: Victaulic#10-DR.

2.5 FIRE EXTINGUISHER

- A. Fire extinguisher(s) will be provided under Division 10.

2.6 MONITOR SWITCHES

- A. Provide supervisory switch on each system control valve(s). The mechanism shall be contained in a weatherproof, die cast aluminum housing, which shall provide a 3/4 inch tapped conduit

entrance and incorporate the necessary facilities for attachment to the valve. Switch housing shall have a minimum rated capacity of 1 amp at 125V AC and 1/4 amp at 24V DC. The entire installed assembly shall be tamperproof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Valve supervisory switches shall be designed for valve mounting either vertically or horizontally. Said switches shall be normally closed type capable of detecting any motion from the valve full open position.

2.7 PIPE AND FITTINGS

A. General

1. Pipe and fitting materials and joint types are specified in the following "Piping Class" paragraphs. Application material and joint type which will be permitted for specific services are specified hereinafter in the Article titled "Piping System Requirements". Where more than one Piping Class is listed under "Piping System Requirements" for a service, use any of listed classes, unless otherwise specified or indicated, but systems' materials must be consistent throughout the work.
2. Pipe and fittings shall conform to the latest issue of the standards referred to hereinafter. Each length of pipe and each fitting shall be marked with the manufacturer's name brand and specification code designation to which it belongs.

B. Piping Class S7

ITEM	LIMITS	DESCRIPTION
PIPE	2-1/2 inch thru 8 inch	ASTM A53 or A135, Schedule 10, black steel
JOINTS & FITTINGS	2-1/2 inch thru 8 inch	Welded or rolled grooved type or mechanical locking type (push-on), UL and FM approved
FLANGES	2-1/2 inch thru 8 inch	Class 150 forged steel

Reference Standards

1. Steel Pipe: ASTM A53, Grade B or ASTM A135 black carbon steel.
2. Welded Fittings for Black Steel Pipe: 2-1/2 inch and larger - ASTM A234, Grade A and ANSI B16.9. All elbows long radius.
3. Flanges for Welded Black Steel Pipe: Forged steel, ASTM A181 Class 60, ANSI B16.5 for Classes 150 and 300.

C. Piping Class S8

ITEM	LIMITS	DESCRIPTION
PIPE	2 inch & smaller	Steel pipe Schedule 40, nipples, Schedule 80, black
JOINTS	2 inch & smaller	Screwed or welded
FITTINGS	2 inch & smaller	Class 150 malleable iron threaded or socket welded

UNIONS	2 inch and smaller	Class 250 threaded, Class 3000 socket welded
FLANGES	All sizes	Class 150 forged steel

Reference Standards

1. Steel Pipe: ASTM A53, Grade B black carbon steel.
2. Malleable Iron Threaded Fittings: ASTM A197 black malleable iron. ANSI B16.3 Classes 150 and 300 banded, with ANSI B2.1 standard taper pipe threads.
3. Welded Fittings for Black Steel Pipe: 2 inch and smaller - Class 3000 forged steel socket welded fittings, ASTM A105 and ANSI B16.11.
4. Flanges for Welded Black Steel Pipe: Forged steel, ASTM A181 Class 60, ANSI B16.5 for Classes 150 and 300.

2.8 PIPING SYSTEM REQUIREMENTS

A. Fire Protection

Service	Valve Type/Class	Pipe Class
Fire Protection Water 1. Above Ground **Comply with NFPA 13 and applicable Building Code, except plastic piping not allowed	FPSV**	S7**, S8**

2.9 SPRINKLER HEADS

A. Provide sprinklers as shown or specified, and finished as follows:

1. Quick response upright type with bronze finish.
2. Quick response pendent type with chrome finish and escutcheon.
3. Quick response recessed pendent type with chrome finish and escutcheon.
4. Quick response concealed pendent type with white cover plate
5. Quick response recessed dry pendent type with chrome finish and escutcheon.
6. Quick response dry pendent type with chrome finish and escutcheon.
7. ESFR sprinklers with K-factor and discharge pressure to match design criteria for pressure storage height and commodity. 3/4 inch or 1 inch NPT inlet as required.
8. Large drop sprinklers upright bronze type with K = 11.2 and 3/4 inch NPT inlet.

B. All sprinkler heads shall be the product of a single manufacturer.

C. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.

D. Sprinklers with rubber O-rings are not permitted.

E. Sprinklers in finished areas attached to concealed piping shall be pendent or sidewall type with

chrome or factory painted finish and escutcheon or cover plate as specified.

- F. Sprinklers in unfinished areas connected to exposed piping shall be upright, pendent or sidewall type with bronze finish unless specified otherwise.
- G. Sprinklers for light hazard occupancies shall be quick response type where required by code.
- H. In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1" NPT Male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head.
 - 1. The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for (6) bends at 48" length.
 - 2. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed and FM Approved for sprinkler services to 175 psi.

2.10 SPRINKLER VALVE ASSEMBLY

- A. Provide in wet pipe sprinkler system, a grooved end riser check valve assembly consisting of a spring loaded stainless steel clapper check valve with ductile iron body, main drain tapping and 1/4 inch inlet and outlet gauge tappings with pressure gauges, globe valves and plugs. Valve is to be used in conjunction with a water flow switch to provide alarm signaling. Valve shall be rated for 300 psi and shall be UL listed and FM approved. Valve shall be Tyco Products Model CV 1FR or equal.
- B. Equip each riser check valve with a Form "C" 2-pole pressure switch similar to Potter Electric Signal Co. for wiring to an electric bell provided by this section.

2.11 SUPERVISORY ALARM SYSTEM

- A. Supervisory Alarm System will be accomplished by the Fire Alarm System provided under Division 28. Flow and valve monitoring switches provided by this section must be compatible with the Fire Alarm System.

2.12 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in this section. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. Valve packing shall not contain asbestos.

B. Refer to Section 22 05 00 for basic valves not specified in this section.

C. Type FPSV, Fire Protection System Valves: Class 175 WWP, UL and FM listed for fire protection service, equivalent to listed figure numbers. Stockham figure numbers are listed except where noted otherwise.

1. Gate Valves 2 Inch and Smaller: Bronze, screw ends, solid disc, OS&Y. B-133.
2. Butterfly Valves 2 Inch and Smaller: Bronze, screwed ends, stainless steel disc and stem with built-in supervisory control switch, Milwaukee Model BB-SCS01.
3. Gate Valves 2-1/2 Inch and Larger: Flanged or grooved ends, iron body, bronze trim, solid disc, OS&Y. G-634 or Victaulic Series 771H
4. Butterfly Valves 2-1/2 Inch and Larger: Lug body, cast iron body, EPDM seat, aluminum-bronze disc, supervisory switch, Kennedy Model 911LE.
5. Check Valves 2-1/2 Inch and Larger: Horizontal swing type, iron body, bronze mounted, composition disc, equipped with ball drip connection. Flanged, G-940. Threaded, G-938.
6. Fire Department Valves at Standpipes: 1-1/2 inch 300 pound brass angle hose valve with red handwheel complete with hose coupling, cap and chain, complying with local fire department requirements.
7. Ball Valves 1 Inch Through 2 Inch: Cast brass body, grooved end, chrome plated brass ball, TFE seat, weatherproof actuator housing with built-in supervisory control switch, Victaulic Series 728.
8. Butterfly Valves 2 Inch Through 12 Inch: Ductile iron, grooved ends, ductile iron disc with EPDM pressure responsive seat, stainless steel stem (Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating), with weatherproof actuator and built-in supervisory control switch, Victaulic Series 705.
9. Check Valves 2 Inch Through 12 Inch: Ductile iron, grooved ends, seat integrally bonded to discs with stainless steel spring and shaft for vertical or horizontal installation, Victaulic Series 717.

2.13 WATER FLOW SWITCHES

A. Provide in wet pipe sprinkler system, flow switch of paddle type with two (2) sets of Form "C" single pole double throw (SPDT) contacts, suitable for maximum 120 volt AC or 24 volt DC electrical service. Paddle type switches shall have a sensitivity setting to signal any flow of water that equals or exceeds the discharge from the smallest orifice sprinkler head attached to the

system. Flow switch shall have an adjustable retard feature.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Refer to Section 22 05 00 for basic requirements.
- B. Manufacturers' Supervision/Inspection: Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer's supervision/inspection services and manufacturer's written certification as specified in Part 1 of this section, and shall at his own expense make any corrections/modifications to his installation work as required by the manufacturer.
 - 1. Grooved joint shall be installed in accordance with the manufacturer's written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)
- C. Provide pressure gauges where shown and as required by authorities having jurisdiction.
- D. Provide suitable means to permit free movement resulting from contraction and expansion.
- E. Install sprinkler heads in all spaces including electrical and elevator machine rooms, elevator shafts, stairways and any open or closed areas that may require protection and areas above and below ducts, etc., in accordance with NFPA 13. Arrange heads to clear all construction features, lights, ducts, piping, etc. Provide all sprinklers as may be required to provide a complete sprinkler system in all areas designed as having a sprinkler system.
- F. No piping foreign to electrical equipment is permitted to be installed in, enter, or pass through electrical equipment rooms, elevator machine rooms or similar areas. Only sprinkler branch piping with sprinkler heads serving such areas as previously listed may be installed. Piping and sprinkler heads are not permitted to be installed directly over any equipment, panels, etc., within this space.
- G. Provide each controlling valve with an approved lettered sign, as specified in Section 22 05 00, Basic Materials and Methods.
- H. Protect sprinkler piping system from earthquake damage in accordance with the requirements of NFPA 13.
- I. This Contractor shall coordinate locations of fire protection system piping with respect to fresh air intake louvers. Routing of piping directly in front of such louvers shall be avoided due to

potential freezing conditions. Refer to mechanical drawings for exact locations for all louvers. All louvers shall be shown on shop drawing submittals.

- J. The Contractor shall be responsible for coordinating all fire protection equipment locations with the locations of all lighting fixtures, HVAC diffusers, ceiling architectural features and structural members. The Contractor is responsible for coordinating the locations of all fire protection piping and equipment with all other trades to prevent obstructions to the required sprinkler discharge pattern and to prevent conflicts with location of piping above finished ceilings.
- K. Sprinkler heads shall be installed in a symmetrical and orderly fashion.
- L. Sprinkler bulb protectors shall be removed by hand. Do not use any tools or devices that could damage the bulb.
- M. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- N. A maximum tolerance of (+) 1/2 inch between two adjacent sprinkler heads and 3/4 inch overall for sprinkler heads aligned parallel and perpendicular to branch lines shall be provided.
- O. Sprinkler heads shall be located in the center of all ceiling tiles.
- P. Piping shall be located so as to avoid areas where sprinkler or standpipe piping may have the potential for freezing.

3.2 ALARM BELL

- A. Provide a 120 V electric bell near the flow switch and alarm valve and wire to one pole of the switch. Connect to nearest emergency 20 amp circuit in accordance with National Electrical Code.
- B. Install bell exposed surface mounted on exterior of building near fire department inlet connection.

3.3 CONNECTIONS TO EXISTING SYSTEM

- A. Extend new system from existing system. Make necessary alterations to existing systems as required and as shown. Match new materials in altered systems with existing materials, unless otherwise indicated.
- B. Be responsible for and repair any leaks developing in existing piping and for damage to existing work due to failure to take proper precautions when making alterations and testing the system.
- C. Refer to Section 22 05 00 for additional instructions in connections with alteration work.

3.4 INTERFACING WITH ELECTRICAL WORK

- A. Refer to Section 22 05 00, Electrical Equipment and Wiring, for requirements regarding motors, starters, and wiring.
- B. Power wiring will be provided under Division 26, Electrical, to the following:
 - 1. Alarm bell
- C. Signal wiring for the connection of the following systems to the fire alarm system will be provided under Division 26, Electrical:
 - 1. Wet Sprinkler System
 - a. Waterflow alarm and valve monitoring switches
 - b. Electric alarm bell

3.5 MONITOR SWITCH

- A. Mount switch so that it will not interfere with operation of shutoff valve. Adjust switch to operate with one revolution of hand-wheel from its normal full open position. Closing of valve shall transmit alarm to annunciator panel and restoration of valve to normal open position shall restore circuit to normal operation. Attempts to remove unit from its mounting or tampering with cover of housing shall transmit signal to annunciator panel and restoration of switch to its mounting position, or replacing cover on housing shall restore circuit to normal operation.

3.6 SPRINKLER VALVE ASSEMBLY

- A. Install electric bell on wall outside of building adjacent to sprinkler valve assembly.

3.7 STANDPIPE SYSTEM, WET

- A. Provide **wet** standpipe system complete with piping, fittings, fire department valves, hose connection and fire department Siamese connection.
- B. During construction, make one standpipe outlet available on each floor without delay, for fire department use.
- C. Install fire hose cabinets with cabinet top maximum 7 feet above floor. Locate angle valve in cabinet 5 feet above floor.
- D. Provide full size check valve and a 3/4 inch ball-drip, installed between fire department connection and check valve, to prevent line from freezing.
- E. Provide pressure gauge at highest most remote hose station.

3.8 TESTING OF PIPING SYSTEMS

- A. Refer to Testing of Piping Systems, General, in Section 22 05 00.
- B. Water Fire Protection System: Test hydrostatically to 200 psig or 50 pounds over static head on system, whichever is greater. Maintain pressure for 2 hours without leakage.

3.9 WATER FLOW SWITCH

- A. May be mounted in horizontal or vertical position. When mounted in horizontal position, mount on top of pipe. Do not mount within 6 inches of a fitting that changes water flow direction or within 24 inches of a valve or drain.

3.10 WET SPRINKLER SYSTEM

- A. Provide wet type sprinkler system consisting of water source, backflow preventer, sprinklers, piping, fittings and hangers, valves, water flow switches, Siamese connection, alarm and accessories.
- B. Install monitored isolation valve, flow switch and test valve in each sprinkler zone as it connects to the main riser.
- C. Run piping concealed above furred ceilings and in joists to minimize obstructions. Expose only heads.
- D. Protect sprinkler heads against mechanical injury with standard guards.
- E. Locate outside alarms on wall of building adjacent to Siamese fire department connection.
- F. Provide full size check valve in Siamese fire department connection line located as near as practicable to point where it joins the system. Install 3/4 inch ball drip between check valve and fire department connection to prevent freezing. Pipe ball drip to outside.
- G. Provide sprinkler heads of rating higher than ordinary, where required and approved by authorities having jurisdiction.
- H. Install sprinkler head guards where heads are low enough to be subject to possible damage, as required or directed.
- I. Seal sleeves of pipes passing through ceiling air plenum space walls or roof above airtight in a manner similar to that specified for watertight sleeves.
- J. Do not allow pipe hangers to pierce ductwork under any circumstances without prior approval of Architect.
- K. Provide on wall near sprinkler alarm valve cabinet(s) containing 24 extra sprinkler heads for each type and wrenches suitable for each head type.
- L. Install inspectors test pipes and connections at points as required and approved by authorities

having jurisdiction, and so that flow of water will be visible.

- M. Grade piping for complete drainage. Provide drain pipes with approved valves and run to accessible place for discharge. Install auxiliary drain pipes at any low points in systems.
- N. Provide system, auxiliary, test and water motor alarm drain lines with valves and pipe to discharge over approved drains or discharge through exterior walls not more than 6 inches above grade as indicated or as required, visible from drain valves, so located that they will not cause water damage to persons or property.
- O. Show required test pipes and drains on working plans.
- P. Training Requirements: Prior to final acceptance, provide 8 (eight) hours operation and maintenance training to Owner's personnel. Include emergency procedures, troubleshooting procedures and unique maintenance and safety requirements. Coordinate dates and times of training period not less than 2 weeks prior to session.
- Q. At each system control riser, antifreeze loop, and auxiliary system control valve provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25. Such general information shall be provided on a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means.

END OF SECTION 21 00 00

SECTION 21 05 00 – COMMON MATERIALS AND METHODS FOR FIRE 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. This Section is intended to describe the common materials and installation methods of the mechanical work and it applies in general to all other Sections under Division 21 and 22.
- B. Due to the small scale of the drawings, all work required is not shown on the floor plans and certain work is shown on flow diagrams, riser diagrams and details. Work of Division 21 and 22 shall include all required work shown on plans, riser diagrams, flow diagrams and details.
- C. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems
 - 2. Transition fittings
 - 3. Dielectric fittings
 - 4. Mechanical sleeve seals
 - 5. Sleeves
 - 6. Escutcheons
 - 7. Grout
 - 8. Fire protection and plumbing demolition
 - 9. Equipment installation requirements common to equipment sections
 - 10. Painting and finishing
 - 11. Concrete bases
 - 12. Hangers and supports for fire protection and plumbing system piping and equipment
 - 13. Identification for fire protection and plumbing piping and equipment

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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.

1.4 REFERENCES

- A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:
 - 1. ASME/ANSI B31: Code for Pressure Piping
 - 2. ASME Boiler and Pressure Vessel Codes
 - 3. AWS D1.1: Structural Welding Code-Steel
 - 4. MSS SP58: Pipe Hangers and Supports – Materials, Design, and Manufacturers
 - 5. MSS SP69: Pipe Hangers and Supports – Selection and Application except spacing for hangers
 - 6. ANSI A13.1: Scheme for Identification of Piping Systems
 - 7. Applicable NFPA Codes and Standards
 - 8. NSF/ANSI 61: Drinking Water System Components

1.5 SUBMITTALS

- A. Provide Product List of factory fabricated items, in accordance with Section 01 60 00 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 21 and 22.
- B. Provide submittals in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.
- C. Product Data: Provide for each type of factory-fabricated product indicated.
- D. Welding certificates.

1.6 WARRANTY AND CONTRACT CLOSEOUT

- A. Comply with warranty and contract closeout requirements specified in Division 01.
- B. Provide Special Warranties and/or warranty service in accordance with Section 01 60 00 “Product Requirements” where specified in the various sections of Division 21 and 22.
- C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 21 and 22.
- D. Provide testing and cleaning reports. Indicate dates of testing and cleaning operations, procedures used and results obtained for each system. Reports shall be certified as complete.

- E. Provide instructions and demonstration to the Owner's representatives for all equipment and systems installed under Division 21 and 22. Instruction and demonstration shall be appropriate for the size and complexity of the installed system.
- F. Include information for all products specified in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe 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.
 - 3. Use welders fully qualified and licensed by the state authorities.
- C. The specifications for certain products and alternative materials may appear in more than one section of Division 21 and 22. Work of Division 21 and 22 shall be coordinated for all sections of Division 21 and 22 to assure that where two or more items of any given product are furnished under Division 21 and 22 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 21 and 22.
- D. Except for spacing of hangers, provide hangers and supports in accordance with the latest issue of Manufacturer's Standardization Society (MSS) Specifications SP 58 and 69.
- E. All pipe, valves, fittings, stops, faucets, and domestic water pumps shall comply with the Federal "Reduction of Lead in Drinking Water Act" NSF/ANSI 61 and NSF/ANSI 372 for lead content of 0.25%.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle all material and equipment in accordance with manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.
- B. 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.
- C. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

- A. The Mechanical systems are indicated on the Fire Protection and Plumbing Drawings. Certain pertinent information and details involving the installation of fire protection and plumbing work appear on Architectural, Structural, Mechanical and Electrical Drawings. Become familiar with all Drawings and incorporate all pertinent requirements.
- B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the plumbing work. Do not scale the Drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.
- C. Arrange for pipe spaces, chases, slots, duct shafts and openings in building structure during progress of construction, to allow for plumbing installations.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Coordinate installation of identification labels with locations of access panels and doors.
- F. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.
- G. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.
- H. Install identification devices prior to installation of ceilings and similar concealment.

1.10 ENERGY PERFORMANCE CRITERIA

- A. All equipment provided under Division 22 shall meet the requirements of the International, or State, Energy Code, ASHRAE Standard 90 or the latest issue of the Standards for Equipment in the National Energy Policy Act (NEPA), whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. In other Part 2 articles of various sections of Division 21 and 22 where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 2. Unless otherwise noted, substitutions of specified manufacturers shall comply with the requirements of Division 01.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 and 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 and 22 piping Sections for special joining materials not listed below.
- B. 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 thickness or specific material is 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.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F493
 - 2. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - 3. ABS Piping: ASTM D2235
 - 4. PVC to ABS Piping Transition ASTM D3138

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with

ends compatible with, piping to be joined.

1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve type coupling.
 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end. Fernco, Mission or equal.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Steel, zinc, dichromate for fire protection reinforced nylon polymer elsewhere. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
4. Thunderline link seal or equal.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings; Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

- A. General: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter to closely fit around pipe, tube, and insulation of insulated piping and an outside diameter that completely covers opening.
- B. One piece construction on exposed piping in finished areas. Elsewhere, split pattern with setscrew. Provide deep pattern type where required to conceal protruding fittings and sleeve.
- C. Provide polished chromium plated escutcheons on pipes passing through walls, floors or ceilings wherever such pipes are exposed to view.

2.9 HANGERS AND SUPPORTS

- A. Acceptable Manufacturers
 1. Other Than Roof Supports
 - a. B-Line Systems, Inc.
 - b. Grinnell Company
 - c. National Pipe Hangers

- d. Penn Construction Industries
 - e. Other approved United States manufacturer whose products comply with the referenced standards.
2. Roof Pipe, Supports
- a. ThyCurb
 - b. Pate
 - c. Roof Products and Systems Co.

B. Reference Standards

- 1. ASTM A36 - Specification for Structural Steel
- 2. ASTM A123 - Zinc (Hot-Dip Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip)
- 3. ASTM A653 G90 - Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process
- 4. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- 5. AWS D1.1 - Structural Welding Code - Steel
- 6. MSS SP58 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Materials, Design and Manufacture
- 7. MSS SP69 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Selection and Application
- 8. NFPA 13 - Standard for the Installation of sprinkler Systems

C. Quality Assurance

- 1. Steel pipe hangers and supports shall have the manufacturer's name, part number and applicable size stamped in the part itself for identification.
- 2. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

D. General

- 1. Except for spacing of the hangers, design and fabrication of pipe hangers, supports and welding attachments shall conform to ANSI B31.9 or B31.1 as applicable.
- 2. Except for spacing of the hangers, hanger types and supports for bare and covered pipe shall conform to MSS SP69 for the temperature range except that only flat wide band hangers shall be used for hangers installed outside of insulation and plastic pipe.
- 3. Except for spacing of pipe hangers and elsewhere as otherwise indicated, horizontal and vertical piping attachment shall conform to the more stringent of this specification or MSS SP58 or MSS SP69. Continuous inserts and expansion bolts may be used.
- 4. All ferrous hangers, supports and hardware located outdoors shall be hot dip galvanized after fabrication per ASTM A123.
- 5. Hangers and clamps for support of bare copper piping shall be coated with copper colored (for identification) baked on epoxy paint. Use additional PVC coating of the epoxy painted hangers where necessary.
- 6. Provide suitable chromium plated brass supports for chromium plated pipe with exposed heads of bolts and screws chromium plated.
- 7. Hangers other than described above shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.

8. Strut channels shall be pregalvanized in accordance with ASTM A653 G90 or shall have an electrodeposited finish.
 9. All hangers and supports shall have some form of adjustment available after installation.
- E. Inserts
1. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
 2. Size inserts to suit threaded hanger rods.
- F. Pipe Hangers and Supports: For plumbing plastic piping systems provide hangers, supports and support channels as recommended by piping manufacturer, use V-bottom clevis hanger with galvanized 18 gauge continuous support channel where required. Provide hangers as follows:
1. Hangers for Pipe Sizes to 1-1/2 Inch: Adjustable carbon steel ring or clevis.
 2. Hangers for Hot or Cold Pipe Sizes 2 Inches to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Adjustable carbon steel clevis.
 3. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke and cast iron roll.
 4. Multiple or Trapeze Hangers: Factory-enameled steel channels with welded spacers and hanger rods or 12 gauge rolled formed ASTM A570 Grade 33 structural quality steel channels (strut), cast iron roll and stand for hot pipe sizes 6 inches and over. Cross section suitable for span and loading. Suspension by outside hanger rods sized for total load on trapeze.
 5. Wall Support for Pipe Sizes to 3 Inches: Carbon steel hook.
 6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support for Hot Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Adjustable pipe saddle and pipe nipple attached to steel base stand, and concrete pier or steel support.
 9. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
 10. Design hangers to impede disengagement by the movement of supported pipe. Provide spring and neoprene hangers as required.
- G. Beam Clamps: Forged steel C-clamps shall include retaining strap, locking nut or other device for nonslip attachment, except LOCKING NUT NOT ALLOWED for project requiring seismic restraints.
- H. Hanger Rod: Steel hanger rod zinc plated per ASTM B633.
- I. Roof Pipe and Equipment Support
1. 18 gauge galvanized steel, unitized construction, straight base section without cant strip and with integral base plate, all welded construction, pressure treated wood nailer, counterflashing with lag screws, internal reinforcement.
 2. Unless otherwise indicated, overall height recommended by SMACNA Fig. 5-4 to provide clearance for roof maintenance, except 36 inches maximum clearance required. If used as pier or curb base for attachment of pipe or steel support, minimum overall height as required for top of pier or curb base not less than 12 inches above finished surface of roofing or ballast as applicable.

3. Furnish sloped curbs when installed on sloped roofs to provide a level support surface.
4. Furnish supports to Division 07 for installation.
5. Refer to other Section of Division 22 "Vibration Isolation and Seismic Restraints for Plumbing Systems" where pipe and/or other equipment requires vibration isolation, or combination support/isolation/restraint unit.

2.10 PIPE ROOF CURB ASSEMBLY

- A. Welded galvanized steel, insulated mounting curb without cant strip and with treated wood nailer. 1-1/2 inches minimum thickness fibrous glass insulation. Curb height as required for top of curb not less than 12 inches above finished roof.
- B. Furnish sloped curbs when installed on sloped roofs and tapered bottom designed for roof slope at curb location to provide level top surface.
- C. Fill in annular space around multiple pipe penetrations within curbed area with mineral wool insulation. Provide acrylic clad thermoplastic cover and pipe boot with stainless steel clamps.
- D. Furnish curb to Division 07 for installation.

2.11 THERMOMETERS

- A. Acceptable Manufacturers
 1. Trerice
 2. Taylor Instrument Company
 3. U.S. Gauge
 4. Weksler
 5. Weiss
- B. ASTM E1, liquid in place thermometer. Cast aluminum case, black baked epoxy enamel finish, 9 inch minimum liquid filled tube, brass stem, adjustable angle type with locking device and with brass union type separable socket. Socket length to suit installation. Mercury filled thermometer not allowed.
- C. Select range of thermometer to indicate normal operating temperatures at midpoint of scale. Scale division of 1 degree F for cold service and 2 degree F for hot service.
- D. Install wells with stem extending to center of pipe. Fill wells with oil or graphite and secure caps.

2.12 PRESSURE GAUGES

- A. Acceptable Manufacturers
 1. Trerice
 2. Taylor Instrument Company
 3. U.S. Gauge

4. Weksler
 5. Weiss
 6. Ashcroft
- B. ASTM B40.1, Grade A phosphor bronze seamless Bourdon spring type with white face, black numerals, 4-1/2-inch cast aluminum case, black baked epoxy enamel finish, brass bronze brushed movement and brass socket. Select range of gauge to indicate normal operating pressure of system at midpoint of scale.
- C. Provide brass snubber of material suitable for system fluid. Provide with needle valve.

2.13 IDENTIFICATION DEVICES AND LABELS

A. General

1. Products specified are manufacturer's standard products of categories and types required for each application as referenced in Part 3 of this section and elsewhere on the drawings or in Division 21 and 22 specifications. Where more than single type is specified for listed application, selection is Contractor's option, but provide single selection for each product category.
 2. Products shall comply with requirements of ANSI A13.1 and OSHA where applicable.
- B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ANSI A13.1. Minimum letter height is 1-1/4 inches for piping and 3/4 inch for access door signs and similar operational instructions.
1. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
 2. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ANSI A13.1, except as otherwise indicated.
- C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers conforming to ANSI A13.1.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ANSI A13.1.
- E. Pipes/Insulation Smaller Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe/insulation at each location.
- F. Pipes/Insulation 6 Inches And Larger: Either full-band or strip type pipe markers, at least 3 times the letter height and of length required for label.
- G. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.
- H. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick. Width 1-1/2 inches wide on pipes with outside diameters (including insulation) less than 6 inches; 2-1/2 inches wide for larger pipes. Color shall comply with ANSI

A13.1 unless otherwise indicated.

- I. Valve Tags: Stamped or engraved brass with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide a hole for fastener. Brass wire-link chain, beaded chain, or S-hook fasteners.
- J. Access Panel Markers: 1/16 inch thick engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed device. Provide center hole for attachment.
- K. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on masonry walls for each page of valve schedule. Polished hardwood or extruded aluminum frame.
- L. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening. 1/16 inch thick for units up to 20 square inches or 8 inch length, 1/8 inch thick for larger units. Self-tapping stainless steel screws or contact-type permanent adhesive.
- M. Plasticized Tags: Preprinted accident-prevention tags, of plasticized card stock. Size approximately 3-1/4 by 5-5/8 inches. Brass grommets and wire fasteners.
- N. Nomenclature: Large-size wording such as "DANGER," "CAUTION," or "DO NOT OPERATE", or as noted on the drawings in the specification.
- O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
- P. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

2.14 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 21 and 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 21 and 22 to assure that all general service valves throughout the work of Division 21 and 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 21 and 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for

Classes 200 and 300, copper-silicon bronze stem.

5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.
6. Domestic water system valve construction shall comply with NSF 61, 372 and Federal law 111-380 and shall be certified as lead free compliant.

B. Types V1 through V5 General Service Valves: Industrial valve construction. Handwheel operator, except where specified to be provided with chain-wheel operator. Figure numbers listed are those of Stockham Valve Co. Valves shall be products of a single manufacturer.

1. Type V1: Class 125 bronze, solder-end, for soldered copper piping 2 inch and smaller in size; 150 psig water or oil working pressure at 250° F. with high temperature nonlead solder joint (95-5 or equivalent as specified in the "Solder" article of this section); 125 psig saturated steam working pressure:

		Swing	
	Ball	Check	Globe
	See Type V9	B309	B14T
*Use B104 where space prevents full extension of rising steam.			

2. Type V2: Class 125 bronze, for screwed piping 2 inch and smaller in size; 125 psig steam working pressure; 200 psig cold water, oil or gas working pressure:

		Swing	Lift		
	Ball	Check	Check	Globe	Angle
	See Type V9	B319	B316	B22T	B222T
*Use B103 where space prevents full extension of rising steam.					

3. Type V3: Class 300 bronze, for screwed piping 2 inch and smaller in size; 300 psig steam working pressure; 600 psig cold water, oil or gas working pressure:

	Swing	Lift		
Ball	Check	Check	Globe	Angle
See Type V9	B375	B367	B74	B266

4. Type V4: Class 125 flanged, iron body, bronze mounted (IBBM) - for copper and steel piping 2-1/2 inch and over in size; 125 psig saturated steam working pressure; 200 psig cold water, oil or gas working pressure:

Gate	Swing		
OS&Y	Check	Globe	Angle
G623	G931	G512	G515

5. Type V5: Class 250 flanged, iron body, bronze mounted (IBBM) - for copper and steel piping 2-1/2 inch and over in size; 250 psig steam working pressure 450° F.; 500 psig cold water, oil

or gas working pressure:

Gate	Swing	
OS&Y	Check	Globe
F667	F947	F532

6. Approved Manufacturers:

- a. Crane
- b. Nibco
- c. Stockham
- d. Hammond
- e. Jomar

C. Balancing Valves

1. Balancing valves shall be calibrated type with bronze body, Class 125, soldered or screwed ends as required. Valves shall have Venturi flow measuring ports.
2. Approved Manufacturers:
 - a. Bell and Gossett Circuit Setter
 - b. Taco
 - c. Armstrong
 - d. Victaulic

D. Drain Valves

1. Valves 3/4 Inch and Smaller in Size: Interior hose bibb, brass, compression type, with renewable seat and male threads for attachment of hose and fitted with wheel handle and cap when not piped to drain. Valves exposed in finished spaces chromium plated.
2. Valves 1 Inch and Larger in Size: Hose end gate valves fitted with cap except that valves indicated as piped to drain shall be standard shutoff type for system.

E. Refer to other sections of Division 21 and 22 for additional valve requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Furnish, deliver, erect, connect, and finish in every detail all materials, equipment and accessories required for the Work.
2. Include in the work and in the bid minor details not usually shown or specified, but manifestly necessary for the proper installation and operation of the various systems, the same as if specified or shown.
3. If any departures from the Contract Documents are deemed necessary, submit details of

- such departure and the reasons therefore to the Architect for approval.
4. Be responsible to request clarification from the Architect on any conflicts represented between the drawings and specifications.
 5. Adequately guard all exposed moving parts of equipment, such that contact by operating personnel will not cause personal damage or injury.

B. Layout and Coordination With Other Trades

1. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of all measurements in connection with the Work. Any change made in major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to use of equipment of a manufacturer other than that used as basis of design shall cause no interference with other Work.
2. Examine the Drawings of other trades, cooperate and coordinate with other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from the arrangements shown are required, consult with other trade involved. Come to agreement as to changed locations and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop drawings to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown on the drawings; provide such offsets or bends as required to meet structural or finish conditions.
4. Coordinate layout with architectural ceilings and lighting layouts and similar work.
5. Coordinate and be responsible for the required clearances in shafts, chases, furred partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review large scale composite Drawings showing space requirements that exceed those shown.
6. Install systems so that they do not interfere with any openings, doors or windows, or with other work, and so as to permit proper access.
7. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
8. Except where greater clearance is specified or required by applicable codes, rules or regulations, install piping, fittings, valves, etc., to provide not less than 1 inch between their finished covering and the structure or adjacent work of any kind. The minimum space between finished hot piping of any kind and adjacent electrical conduit shall be 6 inches.
9. Make reasonable modifications in the layout to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the systems are to be installed in relation to the work of other trades. Issue such Drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades such that reasonable modifications cannot be made, detail and submit such deviation or conflict to the Architect for review.
11. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or as not to provide proper access for maintenance or repair, make

necessary changes to correct the condition at no increase in the Contract sum.

C. Manufacturer's Instructions and Recommendations

1. Perform the installation, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of the specifications.
2. Should a conflict exist between specifications and manufacturer's instructions, consult with the Architect.

D. Electrical Rooms

1. Do not install any piping, or equipment in or through an electrical room or similar room containing electrical equipment, other than piping, or equipment exclusively serving the room or equipment in the room.
2. If there is a conflict between the above requirement and the Drawings, the above shall govern. If reasonable modifications cannot be made to accommodate this requirement, obtain instructions from the Architect before proceeding with the work.

E. Painting

1. Except where specified otherwise in Division 21 and 22, Work of Division 09 will provide painting of fire protection and plumbing systems, equipment and components.
2. Protect all equipment from rust, corrosion, and similar damage by either factory applied or field applied protective coatings.
3. Repair marred and damaged factory painted finishes with manufacturer's touch up paint and application procedures to match original factory finish.

F. Wall and Ceiling Access Doors

1. Access Doors shown on Architectural Drawings will be provided under Division 05.
2. Furnish access doors required for access to concealed valves, air vents, traps, cleanouts, unions, expansion joints, and other equipment where no other means of access is available. Access doors shall be of adequate size for the service requirements, minimum clear opening of 14 inches by 16 inches.
3. Coordinate requirements for access panels and doors for plumbing and fire protection items requiring access that are concealed behind finished surfaces. Access panels and doors shall be specified in Division 08 Section "Access Doors and Frames."

G. Roof Pipe and Equipment Support

1. Work by Division 07 will install all roof pipe or equipment support curbs, furnished by Division 22.
2. Roof pipe and equipment supports specified in various sections of Division 22 shall be coordinated for exact location and type suitable for roof construction.

3.2 PENETRATIONS

A. General

1. Coordinate with other trades as to the size and location of openings to be provided in new floors, walls, roofs and ceilings as construction progresses.
2. Do not cut openings in new or existing floors and walls without proper structural reinforcement.
3. Install both piping and seals so as to maintain integrity of seals with expansion and contraction of piping.
4. Clean Room and Biohazard Laboratory Sealing Requirements:
 - a. Seal completely all penetrations of piping through any surface.
 - b. Seal completely all penetrations of piping through above ceiling full height partitions.
 - c. Seal completely the perimeter of all access doors or panels in any surface.

B. Sleeves

1. Provide each pipe, passing through a masonry or concrete wall, floor or partition, and elsewhere as indicated, with a sleeve made from standard weight galvanized steel pipe for pipe or conduit.
2. Select sleeves two pipe sizes larger than any pipe to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide minimum of 3/8 clearance.
3. Be responsible for the proper location and alignment of all sleeves.
4. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
5. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral water stop flanges, where they are to receive either water tight or hydrostatic seals.

C. Fire Rated Penetrations

1. Provide through-penetration fire-stop sealing system for pipe penetrations through fire or smoke rated construction. Refer to Division 07 for through-penetration fire stop sealing system.
2. Coordinate with Division 07 to determine requirements for sleeves and clearances.

D. Interior Non-Rated Wall Pipe Penetrations

1. For acoustically treated partitions, and walls between mechanical equipment rooms and occupied spaces, fill annular void at penetration with acoustical sealant.

E. Resilient Penetration Sleeve/Seal

1. Provide resilient penetration sleeve seal for piping subject to vibration to prevent transmission to the building structure.
2. Maintain an airtight seal around the penetrating element and prevent rigid contact of the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

F. Floor Pipe Penetrations

1. Provide water stops for new cored openings for piping where such openings are above grade in laboratories, toilet rooms and similar wet service areas and in mechanical rooms, penthouses, and pipe chases.
2. Provide water stops for existing pipe floor openings that do not have sleeves extended above the floor.
3. Provide either a sleeve or angle water stop. Sleeve may be used if the fire-stop sealing method selected by Division 07 allows the use of a sleeve, otherwise provide angle water stop.
4. Sleeve Water Stop: Construct of Schedule 40 galvanized steel pipe, length as required for 1 inch above floor and 1 inch below underside of floor. Provide 1 inch by 1 inch by 1/8 inch galvanized angle clips welded to sleeve at 90 degree intervals and securely fastened to underside of floor. Caulk space between floor opening and sleeve water tight with soft setting waterproof silicone sealant.
5. Angle Water Stop: Construct of standard weight pipe 1 inch long welded to a 1/4 inch circular steel base plate ring fastened to floor with expansion anchors. Base plate ring width as required for anchor clearance from edge of cored opening. Seal between base ring and floor and caulk all edges of base ring with waterproof silicone sealant.
6. Floor penetrations through concrete slabs on grade shall be sleeved as required by the plumbing code. For hydrostatic floor slab penetrations provide Link Seal as specified under exterior wall pipe penetrations.

G. Pipe Penetrations Through Roof

1. Work by Division 07 will provide flashing for piping not subject to vibration and/or thermal movement. Provide counterflashing of 16 ounce copper for sleeves through roof openings provided under Division 21 and 22 to provide a completely weather tight installation.
2. For piping subject to vibration and/or thermal movement, provide pipe sleeve as detailed on the drawings, or use pipe curb where curb is sized to accommodate both required overall pipe and insulation diameter and thermal movement.

H. Exterior Wall Pipe Penetrations

1. Provide compressible synthetic rubber seal with connecting bolts and pressure plates, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Provide sleeve and install seal in accordance with the manufacturer's recommendations to provide air and water tightness above ground and hydrostatic sealing below grade. Caulking or other type mastic is not acceptable.

3.3 ALTERATIONS OF UTILITIES AND SERVICES

- A. Arrange and pay for the relocation, disconnection or removal of existing utilities and services where such utilities and services interfere with new construction. Perform alteration of utilities and services in accordance with rules, regulations and requirements of the involved utility company as well as regulatory agencies having jurisdiction.

3.4 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

- A. Refer to Division 01 Sections "Execution" and "Alteration Project Procedures" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.
- B. Make all necessary alterations to existing Division 21 and 22 systems as required for removing or for connecting or extending these systems to new work and for revisions in existing work as indicated and as required, whether indicated or not. Match new materials in altered systems with existing materials unless otherwise indicated.
- C. Where equipment, and/or piping is removed or disconnected under Division 21 and 22, perform the work in such a manner that no damage is done to the structure or remaining portions of the existing systems. Do not under any circumstance place stress on existing pipe and fittings that are to be reused. Be fully responsible for and repair, at no additional expense to the Owner, any leaks developing in existing piping due to failure to take proper precautions when making alterations.
- D. Disconnect, demolish, and remove plumbing 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: Do not abandon any piping in place unless specifically noted to do so. Drain piping 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 equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 6. All materials and equipment removed or disconnected by Division 21 and 22, which is not to be reused or delivered to Owner, shall be removed from the premises.
- E. 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.
- F. Remove all piping, and equipment hangers and supports.
- G. Cap tight unused connection at mains and risers behind finished surfaces.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 and 22 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 Coordination Drawings.

- C. Install all piping in accordance with best practices of trade and latest code requirements. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Use uniform system materials throughout building.
- D. Install components having pressure rating equal to or greater than system operating pressure.
- E. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum headroom. Cut piping accurately to measurements established at building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible without sags between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.
- F. Pitch all systems for proper venting at high points and to drain at low points where the systems can be completely emptied. Install vents at all high points and drains at all low points, including where offsets and bends in horizontal pipe runs create a low point. Provide drain points with bronze hose end drain valves.
- G. Do not install piping above or through electrical rooms, telecommunication rooms, or similar room having a large collection of electrical equipment.
- H. Keep pipe and fittings clean from cutting burrs, foreign matter and defects in structure and threading. Make all cuts square. Ream after cutting. Bevel plain ends of steel pipe. Clean off scale and dirt inside and outside before assembly. Remove welding slag or other foreign matter inside and outside.
- I. Install piping within building concealed in walls, furred spaces, pipe spaces or above suspended ceilings. Do not build in or bury horizontal piping within partitions. Install exposed piping as closely as possible to walls, ceilings and columns, allowing space for installation of insulation and access for valve operation.
- J. Install piping sections using greatest length possible in all cases. The use of short lengths socketed together will not be allowed.
- K. The use of lampwick or other material for packing threads, caulking or wrapping of joints to stop or prevent leaks or correct faults is not permitted. The use of long screws having right and left hand threads or couplings is not permitted.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- M. Install piping to permit valve servicing and application of insulation.
- N. Provide offsets and loops as required for piping crossing a building expansion joint to accommodate building movement, whether or not shown on the drawings. Provide seismic joints for piping crossing building seismic joints to accommodate building movement, whether or not shown on the drawings. Piping seismic joints shall be designed to accommodate maximum building seismic joint movement. Piping seismic joints shall be Metraflex or equal.
- O. Changes in Pipe Size and Direction

1. Make reduction or increase in pipe size with fittings. Use eccentric reducing fittings in horizontal piping. Use reducing tees in pressure piping for side outlet reduction only, not on run. Bushed fittings, notched or straight runs to form tees, or any similar fabrication method will not be permitted.
 2. Make changes in direction with standard fittings. Mitering of pipe to form elbows or similar fabrication method will not be allowed. Bending of piping will not be permitted.
- P. Chromium Plated and Stainless Steel Piping: Friction wrenches and clamps must be used exclusively in the installation of chromium plated and stainless steel pipe and fittings. Pipe which is cut, dented or otherwise damaged shall be replaced with new pipe.
- Q. Drain Pans
1. Provide drain pans under entire length of any piping, joints or fittings for soil, waste, rainwater or drain piping system which is installed over operating and delivery rooms, nurseries, ICU, food preparation centers, food serving facilities, food storage areas, central services areas and electronic data processing areas.
 2. Fabricate each drain pan not less than 2 inches deep and provide 3/4 inch drain pipe to discharge at nearest convenient drain line, floor drain or other approved drain point. Construct of not less than 18 gauge galvanized steel.
- R. Electrolysis Control
1. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
 2. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric union to prevent electrolytic action between the ferrous and nonferrous metals. At branch connections off mains, provide shut off valve upstream of dielectric union in order to isolate downstream union.
 3. Where copper or brass piping, tubing or fittings are anchored to, supported by, or come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, plastic or equivalent material to assure prevention of electrolysis.
- S. Equipment Piping
1. Verify final locations of equipment for rough in of piping connections.
 2. Provide shut off valves in the supply and return to each item of equipment. Suitably locate equipment isolation valves to facilitate removal of equipment.
 3. Provide piping from pump glands, drain pans, relief valves or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge, terminating with plain end cut at a 45 degree angle.
- T. Expansion and Contraction of Piping
1. The piping installation shall be free of stress. Run all piping with full allowance for expansion or contraction. Base expansion calculations on 50 degree F. installation temperature to 140 degree F. for hot water systems.
 2. Evaluate the complete piping layout and notify Architect of additional anchors or

- expansion joints and any deviations required to compensate for expansion.
3. Make connections to equipment in such a manner as to eliminate undue strains in piping and equipment. Install sufficient number of elbow swings to allow for proper expansion and contraction of piping at the point of connection to mains and equipment.
 4. Fabricate expansion loops with long radius welded fittings in steel piping and with long radius copper sweat fittings in copper piping.
 5. Provide adequate pipe guides as close as possible on each end of the expansion device to preserve alignment and pitch.
 6. Install pipe hangers and supports in such a manner as to not cause an anchor condition in any direction.

U. Pipe Anchors

1. Install anchors where required to direct pipe expansion properly into expansion joints, loops or offsets and to prevent transfer of loading and stresses to connected equipment.
2. Pipe anchors may consist of heavy steel clamps bolted or welded to piping and provided with lugs and bolts for clamping and attaching anchor braces. Design anchors to restrict pipe movement and fasten to main members of building structure in most effective manner to secure desired results.
3. Do not attach supports, anchors or stays in places or in such a manner that will damage construction or integrity of the structure, either during installation, by weight of the pipe, or by expansion and contraction of the pipe.

V. Pipe Insulation Inserts and Shields

1. Refer to Section of Division 22, "Plumbing Insulation" to coordinate specific insulation thicknesses and requirements. At hanger locations for insulated piping 1 ½ inches and larger where hanger support is outside the insulation, provide inserts of exploded silica pipe insulation between pipe and hanger. Density and compression strength suitable for pipe size and support spacing as required by MSS SP-58, Paragraph 9 and MSS SP-69, Table 3. Provide inserts as required for smaller piping to prevent deformation of insulation. Inserts of equal thickness to adjoining insulation, provided with vapor retardant seals, and of proper length to fully support pipe at each hanger location. Manufactured by Value Engineered Products Max Span; or equivalent.
2. At all hanger locations for insulated piping where hanger is outside of insulation, provide galvanized sheet steel shield formed to fit insert/insulation, extending up to pipe centerline. Length 12 inch minimum when insert is not required. Where inserts are provided, length of shield 4 inches less than insert length. Provide shields 16 gauge for piping up to 4 inches, 12 gauge for piping 6 inches and larger.
3. Preformed insulated pipe saddles may be used in lieu of insert and shield where appropriate. Thickness of insert or pipe saddle same thickness as pipe insulation.

3.6 VALVES

A. General

1. Provide valves at locations shown, where specified and where required to properly control piping systems. Provide valves recommended or required by equipment manufacturers and

- codes for proper operation of equipment and shutoff valves to allow isolation of each main and branch service line, whether or not indicated or specified.
2. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
 3. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
 4. Examine threads on valve and mating pipe for form and cleanliness.
 5. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
 6. Do not attempt to repair defective valves; replace with new valves.
 7. Install valves in horizontal piping with stem at or above the center of the pipe.
 8. Install valves in a position to allow full stem movement.
- B. Check Valves: Provide lift check type in steam, air, gas or vapor service lines and after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.
- C. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.

3.7 WELDING, SOLDERING AND BRAZING

- A. Do not employ workers who have not been fully qualified and certified for the specified procedures.
- B. Pipe Welding, Black or Galvanized Steel Pipe: Perform all welding of black or galvanized steel pipe by shielded metallic arc method of fusion welding, in accordance with welding procedures of AWS (American Welding Society) D10.12 recommended procedures for welding low carbon steel pipe, or other approved procedure, conforming to requirements of ASME/ANSI B31.1 for high pressure steam boiler piping and B31.9 elsewhere.
- C. Pipe Welding Stainless Steel Pipe: Refer to other Sections of Division 22 for welding requirements.
- D. Structural Steel Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and 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. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.
- E. Soldering: Comply with the requirements of the AWS Soldering Manual.
- F. Brazing: Comply with the requirements of the AWS Brazing Manual and AWS A5.8 specification for filler materials for brazing.

3.8 UNIONS

- A. In Screwed Steel Pipe, 2 inches and smaller: Screwed, Class 250 malleable iron, brass to iron seat, ground joint union with brass seat ring pressed into head piece. Provide galvanized unions in galvanized pipe.
- B. In Welded Steel Pipe, 2 inches and smaller: Class 3000 carbon steel socket welded union, steel to steel seat and ground joint. Provide stainless steel in stainless steel piping.
- C. In Copper tubing, 2 inches and smaller: Class 200 wrought copper, solder type, brass ground joint union.
- D. Provide companion flanges in piping 2-1/2 inch and larger.

3.9 PIPING CONNECTIONS

- A. Refer to other Sections of Division 21 and 22 for additional requirements.
- B. Flanged Connections: Make with nonasbestos gaskets of 1/8 inch thick best quality material as recommended by manufacturer for the service application. For steam piping, factory manufactured for flange/connection size/type as manufactured by Flexitallic. For other piping services either Flexitallic or gaskets factory cut for flange size as manufactured by Garlock Packing Division, Colt Industries, or equal. Align flange surfaces parallel. Install gasket concentrically positioned. 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 using torque wrench.
- C. Mechanical Couplings: Prepare pipe and install in accordance with manufacturer's instructions. Standard wall steel pipe either roll or cut grooved at Contractor's option, all sizes, except provide cut grooved as required to accommodate thermal expansion and contraction. Heavy wall steel pipe cut grooved all sizes. Light wall steel pipe roll grooved all sizes. Copper tubing roll grooved.
- D. Soldered Joints: Unless noted otherwise, make with appropriate flux and solder. Clean tubing ends and fittings before assembly. For piping 2 inch and larger tin tubing and fittings before assembly. For tubing 2-1/2 inch and larger use circular flame torch for soldering. The use of lead flux or solder and finishing with 50-50 solder is prohibited.
- E. Threaded Pipe: Make full, clean-cut standard ANSI/ASME B1.20.1 taper pipe threads using sharp dies. Carefully cut, ream or file out to size or bore, removing all chips. Use Schedule 80 pipe for all screwed close and shoulder nipples. Do not use all thread nipples. Provide teflon tape or other approved nontoxic joint compound, applied to male thread only.

- F. Welding Connections: Use only factory made welding fittings, same weight as piping, on welded pipe, except that Bonney Forge WELDOLET or THREADOLET, or Allied Type 1 Branchlet fittings, of same weight as connecting piping, may be used for branch takeoffs two or more commercial pipe sizes smaller than main. All elbows long radius.
- G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D2855.
- H. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
- J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.10 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.11 PROTECTION OF WORK

- A. Clean pipe, tubing, fittings, valves, piping specialties, ductwork and equipment before installation and keep clean while the work is in progress.
- B. Securely close open ends of pipe and tubing and openings in other material and equipment until installed, during installation, and until finally connected or otherwise finished, with caps, plugs or other approved closure devices designed for such service.
- C. Protect factory finished equipment, fixtures and devices with approved temporary covering

material where those items are installed so as to be subject to accidental damage or abuse. Contractor shall remove all temporary covering material at the conclusion of the work or as directed.

- D. Protect the work of other trades and property of Owner from damage and assume full responsibility for the cost of repairing or replacing any damage to such work or property caused by the performance of the work under Division 21 and 22.

3.12 CLEANING OF SYSTEMS

- A. Refer to other sections of Division 21 and 22 for additional cleaning and system flushing requirements.
- B. Following completion of system testing, thoroughly clean all piping systems by flushing with water or other approved method, or as otherwise specified. Completely remove all dirt, scale, oil, grease and other foreign substances that may have accumulated in systems during installation.
- C. Carefully wipe out, wire brush, or if necessary, sand blast sections of pipe lines between temporary or permanent strainers and equipment they are to protect. Replace all permanent strainer screens with temporary screens during cleaning process. Remove temporary screens and reinstall permanent screens after cleaning is completed.
- D. Disconnect automatic devices that can become clogged during cleaning process and do not connect permanently until cleaning process is complete.
- E. Clean all piping and equipment of dirt, scale, plaster, concrete, splattered paint and other foreign matter.
- F. Clean all grease and cuttings from stainless steel piping and trim.
- G. Clean all strainers, dirt pockets, drip legs, traps and other accessories that may collect foreign matter.

3.13 EQUIPMENT PADS

- A. Provide reinforced concrete equipment pads for the work specified under Division 21 and 22. Be responsible for preparing equipment pad drawings and setting foundation anchor bolts in time so as not to delay the work. Equipment pads shall be of the types detailed on the drawings.
- B. Reinforce concrete to suit the loads placed on them. Materials and methods shall be as specified in Division 03.
- C. Unless otherwise indicated, extend equipment pads 4 inches above the finished floor and minimum 4 inches beyond the equipment base in all directions. Have the top edges and vertical corners chamfered along the full perimeter. Equipment pads shall have the same surface finish as the adjacent and surrounding floor.

- D. Set with proper templates, epoxy coated anchor bolts and inserts required for proper attachment of the equipment to the concrete foundations. Provide anchor bolts of the same size and number required by the equipment or as recommended by the equipment manufacturer and in accordance with the requirements detailed. Anchor bolts shall be compatible with vibration isolation requirements specified for the equipment.
- E. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, fill the annular space between the anchor bolt and the inside of the pipe sleeve completely for the full length of the pipe sleeve with nonshrink cement grout.
- F. Grout any openings between the top of the concrete foundation and the base of the equipment.

3.14 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 plumbing and fire protection materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.15 GROUTING

- A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, 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.
- B. Packaging: Premixed and factory packaged. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- C. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout.
- D. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout according to manufacturer's written instructions.

3.16 HANGERS AND SUPPORTS

- A. General
 - 1. Support major piping (3 inch and above), tanks and other equipment to the structure above (beams and girders) or by means of struts or brackets to columns. Do not support from floor or roof decks. Do not overload structural members to which supports are attached. Hanger spacing not to exceed MSS SP69.

- a. Provide hangers, rollers, threaded rods, turnbuckles, deflection guides, deflection provisions, inserts, beam clamps and all miscellaneous specialties for attachment of hangers and supports to structure.
 - b. Provide all rods, angles, rails, struts, brace plates, structural steel, platforms and other items required for suspension or support of piping, tanks and equipment.
 - c. Provide supplemental angles, channels, plates or other reinforcement where supports are required between building structural members. Size supports for weight of pipe, pipe contents, equipment fittings and other items, plus a 200 pound live load. Attach supplemental supports in a manner that will not weaken or overload structural members. Weld steel according to AWS D-1.1.
 - d. Attach by welding, clamping, concrete inserts, drilled in mechanical type anchors (Hilti or equal) and other approved means. Adhesive type anchors are not approved.
 - e. Place grout under supports for equipment, and make a smooth bearing surface.
 - f. For seismic restraint, provide double-sided beam clamp loaded perpendicularly to beam for seismic anchor point.
2. No lead shield anchors, powder or power fasteners permitted for attachments.
 3. Do not use perforated strap hangers. Do not use steel strap hangers on piping.
 4. Wherever possible, support shall be provided directly to main steel or concrete framing beams. If spacing of structure exceeds spacing required to support the mechanical work, supplemental channel or unistrut framing shall be designed and provided by the Contractor.
 5. Support all mechanical work independently of other trades. Under no circumstances shall work be supported or suspended from ceiling grids, piping or other supports by other trades.
 6. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
 7. Inserts in precast concrete to support Work of Division 21 and 22 will be furnished and installed by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.
 8. Supports from Joist Construction: Support suspended piping, and equipment at joist panel point locations. Provide any supplementary steel angles or channels as required to fasten to panel point locations. Where this is not possible, reinforce joist from point of support to joist panel points on each side of support with steel angles welded to top and bottom joist chords. Do not hang from joist bridging. Maximum point load and maximum additional load per joist shall not exceed the loads in the table below:

Joist Size	Maximum Point Load	Maximum Additional Load per Existing Joist
SJ8	75#	300#
SJ10	75#	300#
SJ12	75#	300#
SJ14	150#	1000#
SJ16	100#	500#

B. Inserts

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced

- concrete beams wherever practicable.
2. Set inserts in position in form work in advance of concrete work. Provide reinforcement rod placed through opening on top and bent over adjacent concrete reinforcement rods.
 3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
 4. Where inserts are omitted, if approved by Architect, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab or provide drilled in mechanical type anchors, Hilti or equal, after concrete is completely cured.

C. Pipe Hangers and Supports

1. Unless otherwise required to avoid overloading of structural members or for seismic restraint, support horizontal steel and copper piping as follows:

Nominal Pipe Size (inch)	(a) Maximum Distance Between Support (feet)	Hanger Rod Diameter (inch)
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	Steel Pipe	Copper Tubing	
up to 3/4	6	5	3/8
up to 2	6	6	3/8
2-1/2 to 3-1/2	10	8	1/2
4 and 5	12	10	5/8
6	12	10	3/4
8 to 12	14	14	7/8
Trapeze Hanger Rod			(b)

- a. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
 - b. As required to carry weight of trapeze channel, span of piping with contents, insulation and supports, plus a 200 pound live load.
2. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
 3. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers and expansion joints/loops.
 4. Place a hanger within one foot of each horizontal elbow.
 5. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
 6. Unless otherwise required to avoid overloading, of structural members or for seismic restraint, support vertical piping with clamps spaced appropriately as to type and weight of piping, minimum spacing at every other floor and below roof. Support vertical soil pipe at each floor at hub. For exposed piping in stairs, walkways and finished areas, locate clamps below floor and secure to structure below floor as required.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Space hangers for smallest pipe size or provide intermediate supports for smaller pipe as specified above for individual pipes.
 8. Where practical, support riser piping independently of connected horizontal piping.
 9. Support pipe runs in a manner to minimize stress in the pipe or tubing and on bodies of valves and fittings.
 10. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 11. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
 12. For piping subject to sweating (e.g.: domestic cold water), and for insulated piping requiring roller supports, install hangers outside insulation and provide pipe insulation protection shields as specified in this section. For all other piping, hanger may be attached to the piping before insulation is applied or may be installed outside the insulation with insulation protection shields.
 13. Do not support nonferrous piping with ferrous materials even on a temporary basis.
 14. Do not support piping from other piping or ductwork.
 15. Install hanger rods subjected to tension only. Accomplish lateral and axial movements by proper linkage in rod assembly. Secure hanger to hanger rod with two bottom lock nuts.

3.17 IDENTIFICATION

- A. Identify all new equipment, and new exposed and concealed pipe with legible lettering, applied after finish painting, in a color to contrast with basic color in accordance with ANSI A13.1 and OSHA.
- B. Identify piping by name of pipe content and direction of flow near major equipment items, adjacent to valves or flanges, adjacent to gauges or thermometers, at each tee, at changes in direction, on each side of a penetration of a wall or floor, at each access door or panel and then at maximum 20 foot centers in congested areas and 50 foot intervals elsewhere; indicate flow direction with arrows. Identification shall be by means of plastic markers or tape or painted on the finished pipe surface by using stencils. Lettering shall not be smaller than one third of the pipe diameter and directional arrows not less than 1/2-inch wide and 12 inches long.
- C. Identify equipment and operating devices such as switches, starters and similar equipment, by the equipment numbers shown on Drawings or by the Owner's numbering system, if so directed.
 - 1. Include the type of service or the name of areas served.
 - 2. Lettering minimum 1 inch high.
 - 3. Nameplates shall be two tone plastic, or printed white paper enclosed in a transparent, laminated plastic case with permanently sealed edges.
 - 4. Attach securely to equipment, or where this is not practicable attach by brass link chains.
 - 5. Do not stencil surfaces exposed in public areas.
- D. Furnish for each valve, except those immediately adjacent to apparatus, a 2 inch diameter nonferrous metal tag with figures stamped on the tag.
 - 1. Number tags for Plumbing P-1, P-2, etc.; Use Owner's numbering system if so directed.
 - 2. Fasten tags to valves with nonferrous S hooks and nonferrous chains.
 - 3. Where valves are located above removable acoustical tile ceilings, identify the tile section below the valves by an approved color pin system.
 - 4. Furnish duplicate framed schedules showing the location of each valve, system or equipment it serves, manufacturer, and figure number.

3.18 TESTING OF PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Refer to various sections of Division 21 and 22 for additional piping system testing requirements.
- B. Provide materials and equipment required for testing. Test and make tight all new piping systems and connections to existing piping system.
- C. Take precautions during testing to insure safety of personnel and equipment. Provide systems to be pressurized with appropriate gauges and blowouts or relief valve set at a pressure no more than one third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Make good at no increase in Contract sum damage to work or work of other trades caused by failure to observe proper precautions.
- D. Test piping systems prior to application of insulation. Testing as stipulated herein shall be considered minimum, and where tests stipulated by lawful jurisdictional authorities exceed these

requirements, such more stringent tests shall be performed. Tests shall be witnessed and approved by the authorities having jurisdiction over the work.

- E. Concealed work shall remain uncovered until required tests have been completed. Provide proper sectionalizing devices so that portions of a system may be tested as appropriate.
- F. Isolate and exclude from tests all in line equipment, instruments, gauge glasses, flow meters and all other devices not capable of withstanding test pressure.
- G. Use ambient temperature water as testing medium, except where otherwise specified and except where there is a risk of damage due to freezing.
- H. Apply soap solution to all joints of pneumatically tested systems while system is being subjected to test pressure.
- I. Maintain test pressures sufficient length of time to permit thorough inspection of all joints. Where leaks are observed, replace defective work or material. Caulking of screw joints or holes is not acceptable. Repeat entire test as many times as necessary, until successful completion of test with no leaks.
- J. Prepare written report of testing.

3.19 BALANCING, ADJUSTING AND PERFORMANCE TESTING OF PLUMBING SYSTEMS

- A. Testing, adjusting and balancing of water systems will be provided by the Installing Contractor.
- B. Installing Contractor(s) responsible for the work specified in Division 22 shall perform all work necessary to place systems in full operation prior to start of testing, adjusting and balancing work. In addition, Installing Contractor shall perform certain additional preparatory work required for testing, adjusting and balancing as specified in various Sections of Division 22.
- C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.
- D. Furnish approved manufacturer's technical data and shop drawings for equipment, including pump performance curves.
- E. Balance domestic hot water systems so that hot water circulates through all branches. Domestic hot water system balancing valve flow rates shall be selected to provide a maximum of 5° F. temperature loss throughout the system.

3.20 INSTRUCTION AND DEMONSTRATION

- A. Upon completion of all work and all tests, and at a time mutually agreed on by Contractor, Architect and Owner, Installing Contractor shall operate systems in all parts and at their expense for sufficient length of time to demonstrate the mode of operation and definitively determine

whether the systems as a whole are in first class working condition. Immediately correct, at no cost to Owner, any defects that may develop during this period of operation and place systems in first class working condition before being finally turned over to Owner.

- B. Provide experienced operating personnel to instruct Owner's authorized employees in the operation, adjustment and maintenance of systems and equipment installed under this Contract. Provide instructions for the period of time appropriate for the size and complexity of the system, or as requested by Owner.

3.21 MANUFACTURER'S SUPERVISIONS AND STARTUP SERVICE

- A. Include manufacturer's supervision/startup/certification and special instruction service for equipment as specified in various Sections of Division 21 and 22. Be responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified work. Make any corrections/modifications to the installation as required by the manufacturer at no additional cost to Owner.
- B. The manufacturer's engineer or authorized service personnel shall check the equipment for its conformance to the Specifications, for proper installation and run the system in all modes of operation to ascertain that the unit will function properly. Make necessary adjustments to insure optimum efficiency and trouble free service.
- C. After completion of the startup procedures, the manufacturer shall certify, in writing, that the equipment is installed in accordance with their requirements and is operating in accordance with the intent of the Specifications.

3.22 COMMISSIONING

- A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".
- B. Ensure participation of major equipment manufacturers or their representatives.
- C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.
- D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 22 05 00

SECTION 22 05 00 – COMMON MATERIALS AND METHODS FOR PLUMBING

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 is intended to describe the common materials and installation methods of the mechanical work and it applies in general to all other Sections under Division 21 and 22.
- B. Due to the small scale of the drawings, all work required is not shown on the floor plans and certain work is shown on flow diagrams, riser diagrams and details. Work of Division 21 and 22 shall include all required work shown on plans, riser diagrams, flow diagrams and details.
- C. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems
 - 2. Transition fittings
 - 3. Dielectric fittings
 - 4. Sleeves
 - 5. Escutcheons
 - 6. Grout
 - 7. Plumbing demolition
 - 8. Equipment installation requirements common to equipment sections
 - 9. Painting and finishing
 - 10. Hangers and supports for plumbing system piping and equipment
 - 11. Identification for plumbing piping and equipment

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

- E. Concealed, Exterior 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.

1.4 REFERENCES

- A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:
 - 1. ASME/ANSI B31: Code for Pressure Piping
 - 2. ASME Boiler and Pressure Vessel Codes
 - 3. AWS D1.1: Structural Welding Code-Steel
 - 4. MSS SP58: Pipe Hangers and Supports – Materials, Design, and Manufacturers
 - 5. MSS SP69: Pipe Hangers and Supports – Selection and Application except spacing for hangers
 - 6. ANSI A13.1: Scheme for Identification of Piping Systems
 - 7. Applicable NFPA Codes and Standards
 - 8. NSF/ANSI 61: Drinking Water System Components

1.5 SUBMITTALS

- A. Provide Product List of factory fabricated items, in accordance with Section 01 60 00 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 21 and 22.
- B. Provide submittals in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.
- C. Product Data: Provide for each type of factory-fabricated product indicated.
- D. Welding certificates.

1.6 WARRANTY AND CONTRACT CLOSEOUT

- A. Comply with warranty and contract closeout requirements specified in Division 01.
- B. Provide Special Warranties and/or warranty service in accordance with Section 01 60 00 “Product Requirements” where specified in the various sections of Division 21 and 22.
- C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 21 and 22.
- D. Provide testing and cleaning reports. Indicate dates of testing and cleaning operations, procedures used and results obtained for each system. Reports shall be certified as complete.
- E. Provide instructions and demonstration to the Owner’s representatives for all equipment and systems installed under Division 21 and 22. Instruction and demonstration shall be appropriate for the size and complexity of the installed system.

- F. Include information for all products specified in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe 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.
 - 3. Use welders fully qualified and licensed by the state authorities.
- C. The specifications for certain products and alternative materials may appear in more than one section of Division 21 and 22. Work of Division 21 and 22 shall be coordinated for all sections of Division 21 and 22 to assure that where two or more items of any given product are furnished under Division 21 and 22 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 21 and 22.
- D. Except for spacing of hangers, provide hangers and supports in accordance with the latest issue of Manufacturer's Standardization Society (MSS) Specifications SP 58 and 69.
- E. All pipe, valves, fittings, stops, faucets, and domestic water pumps shall comply with the Federal "Reduction of Lead in Drinking Water Act" NSF/ANSI 61 and NSF/ANSI 372 for lead content of 0.25%.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle all material and equipment in accordance with manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.
- B. 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.
- C. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

- A. The Mechanical systems are indicated on the Plumbing Drawings. Certain pertinent information and details involving the installation of plumbing work appear on Architectural, Structural,

Mechanical and Electrical Drawings. Become familiar with all Drawings and incorporate all pertinent requirements.

- B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the plumbing work. Do not scale the Drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.
- C. Arrange for pipe spaces, chases, slots, duct shafts and openings in building structure during progress of construction, to allow for plumbing installations.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Coordinate installation of identification labels with locations of access panels and doors.
- F. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.
- G. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.
- H. Install identification devices prior to installation of ceilings and similar concealment.

1.10 ENERGY PERFORMANCE CRITERIA

- A. All equipment provided under Division 22 shall meet the requirements of the International, or State, Energy Code, ASHRAE Standard 90 or the latest issue of the Standards for Equipment in the National Energy Policy Act (NEPA), whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. In other Part 2 articles of various sections of Division 21 and 22 where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 2. Unless otherwise noted, substitutions of specified manufacturers shall comply with the requirements of Division 01.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 and 22 piping Sections for pipe, tube, and fitting materials and joining methods.

- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 and 22 piping Sections for special joining materials not listed below.
- B. 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 thickness or specific material is 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.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Aboveground Pressure Piping: Pipe fitting.
- B. ; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings; Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

- A. General: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter to closely fit around pipe, tube, and insulation of insulated piping and an outside diameter that completely covers opening.
- B. One piece construction on exposed piping in finished areas. Elsewhere, split pattern with setscrew. Provide deep pattern type where required to conceal protruding fittings and sleeve.
- C. Provide polished chromium plated escutcheons on pipes passing through walls, floors or ceilings wherever such pipes are exposed to view.

2.7 HANGERS AND SUPPORTS

A. Acceptable Manufacturers

1. Other Than Roof Supports

- a. B-Line Systems, Inc.
- b. Grinnell Company
- c. National Pipe Hangers
- d. Penn Construction Industries
- e. Other approved United States manufacturer whose products comply with the referenced standards.

B. Reference Standards

- 1. ASTM A36 - Specification for Structural Steel
- 2. ASTM A123 - Zinc (Hot-Dip Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip)
- 3. ASTM A653 G90 - Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process
- 4. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- 5. AWS D1.1 - Structural Welding Code - Steel
- 6. MSS SP58 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Materials, Design and Manufacture
- 7. MSS SP69 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Selection and Application
- 8. NFPA 13 - Standard for the Installation of sprinkler Systems

C. Quality Assurance

- 1. Steel pipe hangers and supports shall have the manufacturer's name, part number and applicable size stamped in the part itself for identification.
- 2. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

D. General

- 1. Except for spacing of the hangers, design and fabrication of pipe hangers, supports and welding attachments shall conform to ANSI B31.9 or B31.1 as applicable.

2. Except for spacing of the hangers, hanger types and supports for bare and covered pipe shall conform to MSS SP69 for the temperature range except that only flat wide band hangers shall be used for hangers installed outside of insulation and plastic pipe.
3. Except for spacing of pipe hangers and elsewhere as otherwise indicated, horizontal and vertical piping attachment shall conform to the more stringent of this specification or MSS SP58 or MSS SP69. Continuous inserts and expansion bolts may be used.
4. All ferrous hangers, supports and hardware located outdoors shall be hot dip galvanized after fabrication per ASTM A123.
5. Hangers and clamps for support of bare copper piping shall be coated with copper colored (for identification) baked on epoxy paint. Use additional PVC coating of the epoxy painted hangers where necessary.
6. Provide suitable chromium plated brass supports for chromium plated pipe with exposed heads of bolts and screws chromium plated.
7. Hangers other than described above shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
8. Strut channels shall be pregalvanized in accordance with ASTM A653 G90 or shall have an electrodeposited finish.
9. All hangers and supports shall have some form of adjustment available after installation.

E. Inserts

1. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
2. Size inserts to suit threaded hanger rods.

F. Pipe Hangers and Supports: For plumbing plastic piping systems provide hangers, supports and support channels as recommended by piping manufacturer, use V-bottom clevis hanger with galvanized 18 gauge continuous support channel where required.

1. Hangers for Pipe Sizes to 1-1/2 Inch: Adjustable carbon steel ring or clevis.
2. Hangers for Hot or Cold Pipe Sizes 2 Inches to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Adjustable carbon steel clevis.
3. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke and cast iron roll.
4. Multiple or Trapeze Hangers: Factory-enameled steel channels with welded spacers and hanger rods or 12 gauge rolled formed ASTM A570 Grade 33 structural quality steel channels (strut), cast iron roll and stand for hot pipe sizes 6 inches and over. Cross section suitable for span and loading. Suspension by outside hanger rods sized for total load on trapeze.
5. Wall Support for Pipe Sizes to 3 Inches: Carbon steel hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.
7. Vertical Support: Steel riser clamp.
8. Floor Support for Hot Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Adjustable pipe saddle and pipe nipple attached to steel base stand, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
10. Design hangers to impede disengagement by the movement of supported pipe. Provide spring and neoprene hangers as required.

- G. Beam Clamps: Forged steel C-clamps shall include retaining strap, locking nut or other device for nonslip attachment, except LOCKING NUT NOT ALLOWED for project requiring seismic restraints.
- H. Hanger Rod: Steel hanger rod zinc plated per ASTM B633.

2.8 IDENTIFICATION DEVICES AND LABELS

A. General

- 1. Products specified are manufacturer's standard products of categories and types required for each application as referenced in Part 3 of this section and elsewhere on the drawings or in Division 21 and 22 specifications. Where more than single type is specified for listed application, selection is Contractor's option, but provide single selection for each product category.
- 2. Products shall comply with requirements of ANSI A13.1 and OSHA where applicable.

B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ANSI A13.1. Minimum letter height is 1-1/4 inches for piping and 3/4 inch for access door signs and similar operational instructions.

- 1. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
- 2. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ANSI A13.1, except as otherwise indicated.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers conforming to ANSI A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ANSI A13.1.

E. Pipes/Insulation Smaller Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe/insulation at each location.

F. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

G. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick. Width 1-1/2 inches wide on pipes with outside diameters (including insulation) less than 6 inches; 2-1/2 inches wide for larger pipes. Color shall comply with ANSI A13.1 unless otherwise indicated.

H. Valve Tags: Stamped or engraved brass with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide a hole for fastener. Brass wire-link chain, beaded chain, or S-hook fasteners.

I. Access Panel Markers: 1/16 inch thick engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed device. Provide center hole for attachment.

- J. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on masonry walls for each page of valve schedule. Polished hardwood or extruded aluminum frame.
- K. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening. 1/16 inch thick for units up to 20 square inches or 8 inch length, 1/8 inch thick for larger units. Self-tapping stainless steel screws or contact-type permanent adhesive.
- L. Plasticized Tags: Preprinted accident-prevention tags, of plasticized card stock. Size approximately 3-1/4 by 5-5/8 inches. Brass grommets and wire fasteners.
- M. Nomenclature: Large-size wording such as "DANGER," "CAUTION," or "DO NOT OPERATE", or as noted on the drawings in the specification.
- N. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
- O. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

2.9 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 21 and 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 21 and 22 to assure that all general service valves throughout the work of Division 21 and 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 21 and 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for Classes 200 and 300, copper-silicon bronze stem.
5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.
6. Domestic water system valve construction shall comply with NSF 61, 372 and Federal law 111-380 and shall be certified as lead free compliant.

- B. Types V1 through V5 General Service Valves: Industrial valve construction. Handwheel operator, except where specified to be provided with chain-wheel operator. Figure numbers listed are those of Stockham Valve Co. Valves shall be products of a single manufacturer.

1. Type V1: Class 125 bronze, solder-end, for soldered copper piping 2 inch and smaller in size; 150 psig water or oil working pressure at 250° F. with high temperature nonlead solder joint (95-5 or equivalent as specified in the "Solder" article of this section); 125 psig saturated steam working pressure:

		Swing	
	Ball	Check	Globe
	See Type V9	B309	B14T
*Use B104 where space prevents full extension of rising steam.			

2. Approved Manufacturers:

- a. Crane
- b. Nibco
- c. Stockham
- d. Hammond
- e. Jomar

C. Types V9 and V10, Ball Valves

1. Type V9, General Service, 3 Inches and Smaller: Cast bronze body, two piece type with full or conventional port, chrome plated brass ball, RPTFE seats and packing with adjustable stem packing gland, lever handle. 600 psi CWP. Extended stem to suit insulation thickness. Apollo 70 LF series. Valves in copper piping constructed with thermal barrier suitable for installation with nonlead solder joint (95-5 or equivalent as specified in the "Solder" article of this section). Include verification of suitability for high temperature solder with submittal. Where press type fittings and joining system is used, sizes 4 inches and smaller, provide Apollo 77VLF series. Where stainless steel piping systems are used, provide Apollo 76F series. Natural gas and propane system valves shall be Apollo 77G-UL series with NPT ends.

2. Approved Manufacturers:

- a. Apollo
- b. Nibco
- c. Crane
- d. Stockhom
- e. Watts
- f. Hammond
- g. Victaulic
- h. Jomar

D. Type V11, Nonslam (Silent) Check Valve: Combination Pump Valve Co. figure numbers are indicated.

1. 1/2 Inch Through 2 Inch in Size: Model 36, 300 psi, with union end. Bronze body and trim and stainless steel spring.

- E. Type CPBV, Chrome Plated Brass Valves: Similar to Type V2 and V3, except chrome plated brass finish and black composition wheel handle.
- F. Refer to other sections of Division 21 and 22 for additional valve requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Furnish, deliver, erect, connect, and finish in every detail all materials, equipment and accessories required for the Work.
2. Include in the work and in the bid minor details not usually shown or specified, but manifestly necessary for the proper installation and operation of the various systems, the same as if specified or shown.
3. If any departures from the Contract Documents are deemed necessary, submit details of such departure and the reasons therefore to the Architect for approval.
4. Be responsible to request clarification from the Architect on any conflicts represented between the drawings and specifications.
5. Adequately guard all exposed moving parts of equipment, such that contact by operating personnel will not cause personal damage or injury.

B. Layout and Coordination With Other Trades

1. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of all measurements in connection with the Work. Any change made in major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to use of equipment of a manufacturer other than that used as basis of design shall cause no interference with other Work.
2. Examine the Drawings of other trades, cooperate and coordinate with other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from the arrangements shown are required, consult with other trade involved. Come to agreement as to changed locations and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop drawings to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown on the drawings; provide such offsets or bends as required to meet structural or finish conditions.
4. Coordinate layout with architectural ceilings and lighting layouts and similar work.
5. Coordinate and be responsible for the required clearances in shafts, chases, furred partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review large scale composite Drawings showing space requirements that exceed those shown.

6. Install systems so that they do not interfere with any openings, doors or windows, or with other work, and so as to permit proper access.
7. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
8. Except where greater clearance is specified or required by applicable codes, rules or regulations, install piping, fittings, valves, etc., to provide not less than 1 inch between their finished covering and the structure or adjacent work of any kind. The minimum space between finished hot piping of any kind and adjacent electrical conduit shall be 6 inches.
9. Make reasonable modifications in the layout to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the systems are to be installed in relation to the work of other trades. Issue such Drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades such that reasonable modifications cannot be made, detail and submit such deviation or conflict to the Architect for review.
11. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or as not to provide proper access for maintenance or repair, make necessary changes to correct the condition at no increase in the Contract sum.
12. For alterations to existing facilities, be fully responsible for coordinating work with all existing conditions. Verify location of existing piping, and equipment in the field. Relocate or offset new piping, and make reasonable modifications to existing piping, as required to fit in available space whether or not such relocation of offset is shown on the Drawings.

C. Manufacturer's Instructions and Recommendations

1. Perform the installation, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of the specifications.
2. Should a conflict exist between specifications and manufacturer's instructions, consult with the Architect.

D. Electrical Rooms

1. Do not install any piping, or equipment in or through an electrical room or similar room containing electrical equipment, other than piping, or equipment exclusively serving the room or equipment in the room.
2. If there is a conflict between the above requirement and the Drawings, the above shall govern. If reasonable modifications cannot be made to accommodate this requirement, obtain instructions from the Architect before proceeding with the work.

E. Painting

1. Except where specified otherwise in Division 21 and 22, Work of Division 09 will provide painting of plumbing systems, equipment and components.

2. Protect all equipment from rust, corrosion, and similar damage by either factory applied or field applied protective coatings.
3. Repair marred and damaged factory painted finishes with manufacturer's touch up paint and application procedures to match original factory finish.

F. Wall and Ceiling Access Doors

1. Access Doors shown on Architectural Drawings will be provided under Division 05.
2. Furnish access doors required for access to concealed valves, air vents, traps, cleanouts, unions, expansion joints, and other equipment where no other means of access is available. Access doors shall be of adequate size for the service requirements, minimum clear opening of 14 inches by 16 inches.
3. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors shall be specified in Division 08 Section "Access Doors and Frames."

3.2 PENETRATIONS

A. General

1. Coordinate with other trades as to the size and location of openings to be provided in new floors, walls, roofs and ceilings as construction progresses.
2. Do not cut openings in new or existing floors and walls without proper structural reinforcement.
3. Install both piping and seals so as to maintain integrity of seals with expansion and contraction of piping.

B. Sleeves

1. Provide each pipe, passing through a masonry or concrete wall, floor or partition, and elsewhere as indicated, with a sleeve made from standard weight galvanized steel pipe for pipe or conduit.
2. Select sleeves two pipe sizes larger than any pipe to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide minimum of 3/8 clearance.
3. Be responsible for the proper location and alignment of all sleeves.
4. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
5. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral water stop flanges, where they are to receive either water tight or hydrostatic seals.

C. Fire Rated Penetrations

1. Provide through-penetration fire-stop sealing system for pipe penetrations through fire or smoke rated construction. Refer to Division 07 for through-penetration fire stop sealing system.
2. Coordinate with Division 07 to determine requirements for sleeves and clearances.

D. Interior Non-Rated Wall Pipe Penetrations

1. For acoustically treated partitions, and walls between mechanical equipment rooms and occupied spaces, fill annular void at penetration with acoustical sealant.

E. Resilient Penetration Sleeve/Seal

1. Provide resilient penetration sleeve seal for piping subject to vibration to prevent transmission to the building structure.
2. Maintain an airtight seal around the penetrating element and prevent rigid contact of the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

3.3 ALTERATIONS OF UTILITIES AND SERVICES

- A. Arrange and pay for the relocation, disconnection or removal of existing utilities and services where such utilities and services interfere with new construction. Perform alteration of utilities and services in accordance with rules, regulations and requirements of the involved utility company as well as regulatory agencies having jurisdiction.

3.4 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

- A. Refer to Division 01 Sections "Execution" and "Alteration Project Procedures" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.
- B. Make all necessary alterations to existing Division 21 and 22 systems as required for removing or for connecting or extending these systems to new work and for revisions in existing work as indicated and as required, whether indicated or not. Match new materials in altered systems with existing materials unless otherwise indicated.
- C. Continuity of Existing Services
1. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for shutdown activities, coordinate with Architect, Owner and other trades, and obtain written approval from Owner prior to proceeding with the work. Include work scheduled for off hours, when Owner requires that shutdown and interruption of facilities occur during unoccupied times.
 2. Prepare and set notices on services and equipment that are temporarily shut off or disconnected.
- D. Provide shutoff valves to isolate new work from existing and temporary or permanent connections to new work as required for proper testing and cleaning of new work.
- E. All relocations of existing work shall be accomplished using new materials and accessories unless specifically noted otherwise.
- F. Where equipment, and/or piping is removed or disconnected under Division 21 and 22, perform the work in such a manner that no damage is done to the structure or remaining portions of the existing systems. Do not under any circumstance place stress on existing pipe and fittings that

are to be reused. Be fully responsible for and repair, at no additional expense to the Owner, any leaks developing in existing piping due to failure to take proper precautions when making alterations.

- G. Disconnect, demolish, and remove plumbing 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: Do not abandon any piping in place unless specifically noted to do so. Drain piping 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 equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 6. All materials and equipment removed or disconnected by Division 21 and 22, which is not to be reused or delivered to Owner, shall be removed from the premises.
- H. 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.
- I. Remove all piping, and equipment hangers and supports.
- J. Cap tight unused connection at mains and risers behind finished surfaces.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 and 22 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 Coordination Drawings.
- C. Install all piping in accordance with best practices of trade and latest code requirements. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Use uniform system materials throughout building.
- D. Install components having pressure rating equal to or greater than system operating pressure.
- E. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum headroom. Cut piping accurately to measurements established at building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible without sags between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.

- F. Pitch all systems for proper venting at high points and to drain at low points where the systems can be completely emptied. Install vents at all high points and drains at all low points, including where offsets and bends in horizontal pipe runs create a low point. Provide drain points with bronze hose end drain valves.
- G. Do not install piping above or through electrical rooms, telecommunication rooms, or similar room having a large collection of electrical equipment.
- H. Keep pipe and fittings clean from cutting burrs, foreign matter and defects in structure and threading. Make all cuts square. Ream after cutting. Bevel plain ends of steel pipe. Clean off scale and dirt inside and outside before assembly. Remove welding slag or other foreign matter inside and outside.
- I. Install piping within building concealed in walls, furred spaces, pipe spaces or above suspended ceilings. Do not build in or bury horizontal piping within partitions. Install exposed piping as closely as possible to walls, ceilings and columns, allowing space for installation of insulation and access for valve operation.
- J. Install piping sections using greatest length possible in all cases. The use of short lengths socketed together will not be allowed.
- K. The use of lampwick or other material for packing threads, caulking or wrapping of joints to stop or prevent leaks or correct faults is not permitted. The use of long screws having right and left hand threads or couplings is not permitted.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- M. Install piping to permit valve servicing and application of insulation.
- N. Provide offsets and loops as required for piping crossing a building expansion joint to accommodate building movement, whether or not shown on the drawings. Provide seismic joints for piping crossing building seismic joints to accommodate building movement, whether or not shown on the drawings. Piping seismic joints shall be designed to accommodate maximum building seismic joint movement. Piping seismic joints shall be Metraflex or equal.
- O. Changes in Pipe Size and Direction
 - 1. Make reduction or increase in pipe size with fittings. Use eccentric reducing fittings in horizontal piping. Use reducing tees in pressure piping for side outlet reduction only, not on run. Bushed fittings, notched or straight runs to form tees, or any similar fabrication method will not be permitted.
 - 2. Make changes in direction with standard fittings. Mitering of pipe to form elbows or similar fabrication method will not be allowed. Bending of piping will not be permitted.
- P. Chromium Plated and Stainless Steel Piping: Friction wrenches and clamps must be used exclusively in the installation of chromium plated and stainless steel pipe and fittings. Pipe which is cut, dented or otherwise damaged shall be replaced with new pipe.

Q. Electrolysis Control

1. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
2. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric union to prevent electrolytic action between the ferrous and nonferrous metals. At branch connections off mains, provide shut off valve upstream of dielectric union in order to isolate downstream union.
3. Where copper or brass piping, tubing or fittings are anchored to, supported by, or come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, plastic or equivalent material to assure prevention of electrolysis.

R. Equipment Piping

1. Verify final locations of equipment for rough in of piping connections.
2. Provide shut off valves in the supply and return to each item of equipment. Suitably locate equipment isolation valves to facilitate removal of equipment.
3. Provide piping from pump glands, drain pans, relief valves or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge, terminating with plain end cut at a 45 degree angle.

S. Expansion and Contraction of Piping

1. The piping installation shall be free of stress. Run all piping with full allowance for expansion or contraction. Base expansion calculations on 50 degree F. installation temperature to 140 degree F. for hot water systems.
2. Evaluate the complete piping layout and notify Architect of additional anchors or expansion joints and any deviations required to compensate for expansion.
3. Make connections to equipment in such a manner as to eliminate undue strains in piping and equipment. Install sufficient number of elbow swings to allow for proper expansion and contraction of piping at the point of connection to mains and equipment.
4. Fabricate expansion loops with long radius welded fittings in steel piping and with long radius copper sweat fittings in copper piping.
5. Provide adequate pipe guides as close as possible on each end of the expansion device to preserve alignment and pitch.
6. Install pipe hangers and supports in such a manner as to not cause an anchor condition in any direction.

T. Pipe Anchors

1. Install anchors where required to direct pipe expansion properly into expansion joints, loops or offsets and to prevent transfer of loading and stresses to connected equipment.
2. Pipe anchors may consist of heavy steel clamps bolted or welded to piping and provided with lugs and bolts for clamping and attaching anchor braces. Design anchors to restrict pipe movement and fasten to main members of building structure in most effective manner to secure desired results.
3. Do not attach supports, anchors or stays in places or in such a manner that will damage construction or integrity of the structure, either during installation, by weight of the pipe, or by expansion and contraction of the pipe.

U. Pipe Insulation Inserts and Shields

1. Refer to Section of Division 22, "Plumbing Insulation" to coordinate specific insulation thicknesses and requirements. At hanger locations for insulated piping 1 ½ inches and larger where hanger support is outside the insulation, provide inserts of exploded silica pipe insulation between pipe and hanger. Density and compression strength suitable for pipe size and support spacing as required by MSS SP-58, Paragraph 9 and MSS SP-69, Table 3. Provide inserts as required for smaller piping to prevent deformation of insulation. Inserts of equal thickness to adjoining insulation, provided with vapor retardant seals, and of proper length to fully support pipe at each hanger location. Manufactured by Value Engineered Products Max Span; or equivalent.
2. At all hanger locations for insulated piping where hanger is outside of insulation, provide galvanized sheet steel shield formed to fit insert/insulation, extending up to pipe centerline. Length 12 inch minimum when insert is not required. Where inserts are provided, length of shield 4 inches less than insert length. Provide shields 16 gauge for piping up to 4 inches, 12 gauge for piping 6 inches and larger.
3. Preformed insulated pipe saddles may be used in lieu of insert and shield where appropriate. Thickness of insert or pipe saddle same thickness as pipe insulation.

3.6 VALVES

A. General

1. Provide valves at locations shown, where specified and where required to properly control piping systems. Provide valves recommended or required by equipment manufacturers and codes for proper operation of equipment and shutoff valves to allow isolation of each main and branch service line, whether or not indicated or specified.
2. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
3. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
4. Examine threads on valve and mating pipe for form and cleanliness.
5. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
6. Do not attempt to repair defective valves; replace with new valves.
7. Install valves in horizontal piping with stem at or above the center of the pipe.
8. Install valves in a position to allow full stem movement.

- B. Check Valves: Provide lift check type in steam, air, gas or vapor service lines and after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.

- C. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.
- D. Provide chromium plated valves in chromium plated piping. Provide steam valves in chromium plated piping with composition hand wheels which shall remain reasonably cool in service.

3.7 WELDING, SOLDERING AND BRAZING

- A. Do not employ workers who have not been fully qualified and certified for the specified procedures.
- B. Structural Steel Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and 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. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.
- C. Soldering: Comply with the requirements of the AWS Soldering Manual.

3.8 UNIONS

- A. In Screwed Steel Pipe, 2 inches and smaller: Screwed, Class 250 malleable iron, brass to iron seat, ground joint union with brass seat ring pressed into head piece. Provide galvanized unions in galvanized pipe.
- B. In Welded Steel Pipe, 2 inches and smaller: Class 3000 carbon steel socket welded union, steel to steel seat and ground joint. Provide stainless steel in stainless steel piping.
- C. In Copper tubing, 2 inches and smaller: Class 200 wrought copper, solder type, brass ground joint union.
- D. In Brass Piping, 2 inches and smaller: Class 250 cast bronze, screwed ends, brass ground joint unions. Provide chromium plated unions in chromium plated piping.
- E. Provide companion flanges in piping 2-1/2 inch and larger.

3.9 PIPING CONNECTIONS

- A. Refer to other Sections of Division 21 and 22 for additional requirements.
- B. Mechanical Couplings: Prepare pipe and install in accordance with manufacturer's instructions. Standard wall steel pipe either roll or cut grooved at Contractor's option, all sizes, except

provide cut grooved as required to accommodate thermal expansion and contraction. Heavy wall steel pipe cut grooved all sizes. Light wall steel pipe roll grooved all sizes. Copper tubing roll grooved.

- C. Soldered Joints: Unless noted otherwise, make with appropriate flux and solder. Clean tubing ends and fittings before assembly. For piping 2 inch and larger tin tubing and fittings before assembly. For tubing 2-1/2 inch and larger use circular flame torch for soldering. The use of lead flux or solder and finishing with 50-50 solder is prohibited.
- D. Threaded Pipe: Make full, clean-cut standard ANSI/ASME B1.20.1 taper pipe threads using sharp dies. Carefully cut, ream or file out to size or bore, removing all chips. Use Schedule 80 pipe for all screwed close and shoulder nipples. Do not use all thread nipples. Provide teflon tape or other approved nontoxic joint compound, applied to male thread only.

3.10 PROTECTION OF WORK

- A. Clean pipe, tubing, fittings, valves, piping specialties, ductwork and equipment before installation and keep clean while the work is in progress.
- B. Securely close open ends of pipe and tubing and openings in other material and equipment until installed, during installation, and until finally connected or otherwise finished, with caps, plugs or other approved closure devices designed for such service.
- C. Protect factory finished equipment, fixtures and devices with approved temporary covering material where those items are installed so as to be subject to accidental damage or abuse. Contractor shall remove all temporary covering material at the conclusion of the work or as directed.
- D. Protect the work of other trades and property of Owner from damage and assume full responsibility for the cost of repairing or replacing any damage to such work or property caused by the performance of the work under Division 21 and 22.

3.11 CLEANING OF SYSTEMS

- A. Refer to other sections of Division 21 and 22 for additional cleaning and system flushing requirements.
- B. Following completion of system testing, thoroughly clean all piping systems by flushing with water or other approved method, or as otherwise specified. Completely remove all dirt, scale, oil, grease and other foreign substances that may have accumulated in systems during installation.
- C. Carefully wipe out, wire brush, or if necessary, sand blast sections of pipe lines between temporary or permanent strainers and equipment they are to protect. Replace all permanent strainer screens with temporary screens during cleaning process. Remove temporary screens and reinstall permanent screens after cleaning is completed.
- D. Disconnect automatic devices that can become clogged during cleaning process and do not connect permanently until cleaning process is complete.

- E. Clean all piping and equipment of dirt, scale, plaster, concrete, splattered paint and other foreign matter.
- F. Clean all grease and cuttings from stainless steel piping and trim.
- G. Clean all strainers, dirt pockets, drip legs, traps and other accessories that may collect foreign matter.

3.12 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 plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.13 GROUTING

- A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, 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.
- B. Packaging: Premixed and factory packaged. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- C. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout.
- D. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout according to manufacturer's written instructions.

3.14 HANGERS AND SUPPORTS

- A. General
 - 1. Support major piping (3 inch and above), tanks and other equipment to the structure above (beams and girders) or by means of struts or brackets to columns. Do not support from floor or roof decks. Do not overload structural members to which supports are attached. Hanger spacing not to exceed MSS SP69.
 - a. Provide hangers, rollers, threaded rods, turnbuckles, deflection guides, deflection provisions, inserts, beam clamps and all miscellaneous specialties for attachment of hangers and supports to structure.

- b. Provide all rods, angles, rails, struts, brace plates, structural steel, platforms and other items required for suspension or support of piping, tanks and equipment.
 - c. Provide supplemental angles, channels, plates or other reinforcement where supports are required between building structural members. Size supports for weight of pipe, pipe contents, equipment fittings and other items, plus a 200 pound live load. Attach supplemental supports in a manner that will not weaken or overload structural members. Weld steel according to AWS D-1.1.
 - d. Attach by welding, clamping, concrete inserts, drilled in mechanical type anchors (Hilti or equal) and other approved means. Adhesive type anchors are not approved.
 - e. Place grout under supports for equipment, and make a smooth bearing surface.
 - f. For seismic restraint, provide double-sided beam clamp loaded perpendicularly to beam for seismic anchor point.
2. No lead shield anchors, powder or power fasteners permitted for attachments.
 3. Do not use perforated strap hangers. Do not use steel strap hangers on piping.
 4. Wherever possible, support shall be provided directly to main steel or concrete framing beams. If spacing of structure exceeds spacing required to support the mechanical work, supplemental channel or unistrut framing shall be designed and provided by the Contractor.
 5. Support all mechanical work independently of other trades. Under no circumstances shall work be supported or suspended from ceiling grids, piping or other supports by other trades.
 6. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
 7. Inserts in precast concrete to support Work of Division 21 and 22 will be furnished and installed by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.
 8. Supports from Joist Construction: Support suspended piping, and equipment at joist panel point locations. Provide any supplementary steel angles or channels as required to fasten to panel point locations. Where this is not possible, reinforce joist from point of support to joist panel points on each side of support with steel angles welded to top and bottom joist chords. Do not hang from joist bridging. Maximum point load and maximum additional load per joist shall not exceed the loads in the table below:

Existing Joist Size	Maximum Point Load	Maximum Additional Load per Existing Joist
SJ8	75#	300#
SJ10	75#	300#
SJ12	75#	300#
SJ14	150#	1000#
SJ16	100#	500#

B. Inserts

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in form work in advance of concrete work. Provide reinforcement rod placed through opening on top and bent over adjacent concrete reinforcement rods.
3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

4. Where inserts are omitted, if approved by Architect, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab or provide drilled in mechanical type anchors, Hilti or equal, after concrete is completely cured.

C. Pipe Hangers and Supports

1. Unless otherwise required to avoid overloading of structural members or for seismic restraint, support horizontal steel and copper piping as follows:

Nominal Pipe Size (inch)	(a) Maximum Distance Between Support (feet)		Hanger Rod Diameter (inch)
	Steel Pipe	Copper Tubing	
up to 3/4	6	5	3/8
up to 2	6	6	3/8
2-1/2 to 3-1/2	10	8	1/2
4 and 5	12	10	5/8
Rod			(b)

- a. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
 - b. As required to carry weight of trapeze channel, span of piping with contents, insulation and supports, plus a 200 pound live load.
2. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
 3. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers and expansion joints/loops.
 4. Place a hanger within one foot of each horizontal elbow.
 5. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
 6. Unless otherwise required to avoid overloading, of structural members or for seismic restraint, support vertical piping with clamps spaced appropriately as to type and weight of piping, minimum spacing at every other floor and below roof. Support vertical soil pipe at each floor at hub. For exposed piping in stairs, walkways and finished areas, locate clamps below floor and secure to structure below floor as required.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Space hangers for smallest pipe size or provide intermediate supports for smaller pipe as specified above for individual pipes.
 8. Where practical, support riser piping independently of connected horizontal piping.
 9. Support pipe runs in a manner to minimize stress in the pipe or tubing and on bodies of valves and fittings.
 10. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 11. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
 12. For piping subject to sweating (e.g.: domestic cold water), and for insulated piping requiring roller supports, install hangers outside insulation and provide pipe insulation protection shields as specified in this section. For all other piping, hanger may be

attached to the piping before insulation is applied or may be installed outside the insulation with insulation protection shields.

13. Do not support nonferrous piping with ferrous materials even on a temporary basis.
14. Do not support piping from other piping or ductwork.
15. Install hanger rods subjected to tension only. Accomplish lateral and axial movements by proper linkage in rod assembly. Secure hanger to hanger rod with two bottom lock nuts.

3.15 IDENTIFICATION

- A. Identify all new and altered equipment, and new and altered exposed and concealed pipe with legible lettering, applied after finish painting, in a color to contrast with basic color in accordance with ANSI A13.1 and OSHA.
- B. Identify piping by name of pipe content and direction of flow near major equipment items, adjacent to valves or flanges, adjacent to gauges or thermometers, at each tee, at changes in direction, on each side of a penetration of a wall or floor, at each access door or panel and then at maximum 20 foot centers in congested areas and 50 foot intervals elsewhere; indicate flow direction with arrows. Identification shall be by means of plastic markers or tape or painted on the finished pipe surface by using stencils. Lettering shall not be smaller than one third of the pipe diameter and directional arrows not less than 1/2-inch wide and 12 inches long.
- C. Identify equipment and operating devices such as switches, starters and similar equipment, by the equipment numbers shown on Drawings or by the Owner's numbering system, if so directed.
 1. Include the type of service or the name of areas served.
 2. Lettering minimum 1 inch high.
 3. Nameplates shall be two tone plastic, or printed white paper enclosed in a transparent, laminated plastic case with permanently sealed edges.
 4. Attach securely to equipment, or where this is not practicable attach by brass link chains.
 5. Do not stencil surfaces exposed in public areas.
- D. Furnish for each valve, except those immediately adjacent to apparatus, a 2 inch diameter nonferrous metal tag with figures stamped on the tag.
 1. Number tags for Plumbing P-1, P-2, etc.; Use Owner's numbering system if so directed.
 2. Fasten tags to valves with nonferrous S hooks and nonferrous chains.
 3. Where valves are located above removable acoustical tile ceilings, identify the tile section below the valves by an approved color pin system.
 4. Furnish duplicate framed schedules showing the location of each valve, system or equipment it serves, manufacturer, and figure number.

3.16 TESTING OF PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Refer to various sections of Division 21 and 22 for additional piping system testing requirements.
- B. Provide materials and equipment required for testing. Test and make tight all new piping systems and alterations and connections to existing piping system.

- C. Take precautions during testing to insure safety of personnel and equipment. Provide systems to be pressurized with appropriate gauges and blowouts or relief valve set at a pressure no more than one third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Make good at no increase in Contract sum damage to work or work of other trades caused by failure to observe proper precautions.
- D. Test piping systems prior to application of insulation. Testing as stipulated herein shall be considered minimum, and where tests stipulated by lawful jurisdictional authorities exceed these requirements, such more stringent tests shall be performed. Tests shall be witnessed and approved by the authorities having jurisdiction over the work.
- E. Concealed work shall remain uncovered until required tests have been completed. Provide proper sectionalizing devices so that portions of a system may be tested as appropriate.
- F. Isolate and exclude from tests all in line equipment, instruments, gauge glasses, flow meters and all other devices not capable of withstanding test pressure.
- G. Use ambient temperature water as testing medium, except where otherwise specified and except where there is a risk of damage due to freezing.
- H. Apply soap solution to all joints of pneumatically tested systems while system is being subjected to test pressure.
- I. Maintain test pressures sufficient length of time to permit thorough inspection of all joints. Where leaks are observed, replace defective work or material. Caulking of screw joints or holes is not acceptable. Repeat entire test as many times as necessary, until successful completion of test with no leaks.
- J. Prepare written report of testing.

3.17 BALANCING, ADJUSTING AND PERFORMANCE TESTING OF PLUMBING SYSTEMS

- A. Testing, adjusting and balancing of water systems will be provided by the Installing Contractor.
- B. Installing Contractor(s) responsible for the work specified in Division 22 shall perform all work necessary to place systems in full operation prior to start of testing, adjusting and balancing work. In addition, Installing Contractor shall perform certain additional preparatory work required for testing, adjusting and balancing as specified in various Sections of Division 22.
- C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.
- D. Furnish approved manufacturer's technical data and shop drawings for equipment, including pump performance curves.

- E. Balance domestic hot water systems so that hot water circulates through all branches. Domestic hot water system balancing valve flow rates shall be selected to provide a maximum of 5° F. temperature loss throughout the system.

3.18 INSTRUCTION AND DEMONSTRATION

- A. Upon completion of all work and all tests, and at a time mutually agreed on by Contractor, Architect and Owner, Installing Contractor shall operate systems in all parts and at their expense for sufficient length of time to demonstrate the mode of operation and definitively determine whether the systems as a whole are in first class working condition. Immediately correct, at no cost to Owner, any defects that may develop during this period of operation and place systems in first class working condition before being finally turned over to Owner.
- B. Provide experienced operating personnel to instruct Owner's authorized employees in the operation, adjustment and maintenance of systems and equipment installed under this Contract. Provide instructions for the period of time appropriate for the size and complexity of the system, or as requested by Owner.

3.19 MANUFACTURER'S SUPERVISIONS AND STARTUP SERVICE

- A. Include manufacturer's supervision/startup/certification and special instruction service for equipment as specified in various Sections of Division 21 and 22. Be responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified work. Make any corrections/modifications to the installation as required by the manufacturer at no additional cost to Owner.
- B. The manufacturer's engineer or authorized service personnel shall check the equipment for its conformance to the Specifications, for proper installation and run the system in all modes of operation to ascertain that the unit will function properly. Make necessary adjustments to insure optimum efficiency and trouble free service.
- C. After completion of the startup procedures, the manufacturer shall certify, in writing, that the equipment is installed in accordance with their requirements and is operating in accordance with the intent of the Specifications.

3.20 COMMISSIONING

- A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".
- B. Ensure participation of major equipment manufacturers or their representatives.
- C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

- D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 22 05 00

SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

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 extent of electrical equipment and electrical wiring that is responsibility of Division 22.
- B. Section includes general requirements for motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- C. Related Sections
 - 1. Section 22 05 00, Common Materials and Methods for Plumbing Systems.
 - 2. Variable Frequency Motor Speed Controllers furnished by Division 22 are specified in Division 26.

1.3 REFERENCE STANDARDS

- A. ANSI/IEEE 112 (C50.20): Test Procedure for single Phase Induction Motors
- B. ANSI/IEEE 114 (C50.21): Test Procedure for Polyphase Induction Motors and Generators
- C. NFPA 70: National Electric Code (NEC)
- D. UL: Underwriters Laboratories

1.4 SUBMITTALS

- A. Product Data: Include with equipment submittals, data pertinent to electrical characteristics, motor size, type, power requirements, wiring requirements.

1.5 QUALITY ASSURANCE

- A. Provide electrical products, including those factory mounted or factory furnished, which have been tested, listed and labeled with Underwriters' Laboratory (UL) or Electrical Testing Laboratory (ETL).

- B. There shall be no field modifications made to any materials, equipment and systems that would violate the listing and labeling.
- C. Comply with Division 26, NEC and NEMA as applicable to wiring methods, materials and equipment and equipment, construction and installation.

1.6 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. Wiring Under Division 26 "Electrical"
 - 1. Power wiring under Division 26 will include power feeders from source of building power to wiring terminals on the equipment; unit mounted disconnects, or control panels unless indicated in other sections of Division 22.
 - 2. Where disconnect switches for equipment are provided by Division 26, power wiring under Division 26 will include wiring from disconnect to wiring terminals on the equipment.
- C. Wiring Under Division 25 "Integrated Automation "
 - 1. Except on factory packaged equipment, wiring under Division 25 shall include all connections to control devices, wiring of pressure and flow control switches, flow meters and similar plumbing-electrical devices for plumbing systems to control panels, interlock wiring, control relays, and minor power wiring to auxiliary components for major pieces of apparatus such as solenoid valves and control valve motors.
 - 2. Wiring under Division 25 shall include all signal wiring from plumbing equipment to building automation system.
- D. Provide all other power and control wiring for Division 22 systems and equipment in accordance with the requirements of Division 26, required for complete operation, including wiring that is specified for factory prewired equipment, but not so provided.
- E. Short Circuit Current Rating (SCCR) for Plumbing Equipment
 - 1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered mechanical equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the plumbing equipment

shall be equal or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

2. Plumbing equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment, and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.
3. All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned "Resubmit" or "Rejected".
4. No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

F. Electrical Ratings

1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be submitted for approval and be completed by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 ELECTRICAL WIRING

- A. Electrical wiring provided by Division 22 shall be in accordance with the requirements of Division 26.

2.2 CONTROL PANELS

- A. Include in control panels provided as a part of apparatus specified in Division 22, fused disconnect, circuit breaker or motor circuit protector combination starter with overload protection for each motor, contactors, and electric heaters, if required. Provide 120 volt control circuit and other required circuit protection. Where remote controls are required, they shall operate at 120 volt maximum, with properly fused control transformer provided for that purpose.

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

- A. Unless otherwise stated herein or on the drawings, power wiring will be provided under Division 26 and control wiring will be provided under Division 22. Provide power and control wiring for Division 22 systems and equipment for interconnecting wiring on apparatus that has not been factory installed.
- B. Coordinate power wiring requirements with Division 26 for locations of electrical panelboards to connect Division 22 system as specified.

3.2 POWER FACTOR CORRECTION

- A. Deliver capacitors not factory mounted on equipment to Division 26 for field installation and wiring.

END OF SECTION 22 05 13

SECTION 22 07 00 - PLUMBING 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. Plumbing Piping Insulation
2. Adhesives, mastics, tapes
3. Recovering

B. Related Sections

1. Warranty, pipe insulation insert and shields are specified in Section 22 05 00, "Common Materials and Methods for Plumbing Systems".

1.3 DEFINITIONS

- A. Cold Surfaces: Normal operating temperatures less than 75° F.
- B. Density: Is expressed in pcf (pounds/cu. ft.).
- C. Dual Temperature Surfaces: Normal operating temperatures that vary from hot to cold.
- D. Hot Surfaces: Normal operating temperatures of 100° F. or higher.
- E. Thermal Conductivity ("K" value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of (Btu x inch)/(h x sq. ft. x ° F.).
- F. Through Resistivity ("R" value): Represents the reciprocal of thermal conductivity ("K" value).

1.4 REFERENCES

- A. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- B. ASTM E84 Surface Burning Characteristics of Building Materials.

- C. MICA Standards: National Commercial & Industrial Insulation Standards published by the Midwest Insulation Contractors Association. Endorsed by National Insulation Contractors Association (NICA) and its regional associations.
- D. NFPA 255 Test of Surface Burning Characteristics of Building Materials.
- E. UL 723 Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, as applicable).
- B. Product Schedule or List: Prepare a summary of products required and clearly indicate location of their intended use.
- C. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. For products where color is specified, show the full range of colors available for each type of finish.

1.6 QUALITY ASSURANCE

- A. Materials, job conditions and installation shall be in compliance with the applicable Building and Plumbing Codes.
- B. Installation shall be done in a workmanlike manner by skilled and experienced workers who are regularly employed in commercial/industrial insulation work, in accordance with manufacturer's recommendations and instructions and best practices of the trade.
- C. Comply with the more stringent of the requirements of this specification or the requirements of the MICA standards.
- D. Insulation materials manufacturing facilities must be certified and registered with an approved registrar for conformance with ISO 9000 quality standard.
- E. Fire Performance Characteristics
 - 1. Insulation, jacketing materials, PVC covers, tapes, adhesives, mastics, cements and finish coatings shall have a composite noncombustible fire and smoke hazard rating and label, as tested in accordance with United States Public Health Service requirements, ASTM E84, NFPA 255 and UL 723 not exceeding Flame Spread 25 and Smoke Developed 50.
 - 2. Indoor Recovering Canvas Jackets: UL listed fabric, 6 ounce per square yard, unless otherwise specified, attached with a lagging fire retardant and waterproof adhesive.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Deliver materials to job site in original nonbroken factory packaging, labeled with manufacturer's density and thickness and store in a safe, dry place.
- B. No insulation material shall be installed that has become damaged in any way.
- C. Do not install, and remove from the site, any insulation material that has become wet because of transit or job site exposure to moisture or water. Remove insulation from piping and/or equipment which has become wet. Reinsulate as required.

1.8 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Common Materials and Methods for Plumbing."
- B. Coordinate clearance requirements with installing contractor for insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

- A. Schedule insulation application after pressure testing of piping systems. Insulation application may begin on segments that have satisfactory test results.
- B. Schedule insulation application on water piping prior to activation of system. Do not install insulation to surfaces where condensation is present.
- C. Schedule insulation application after installation and testing of heat trace tape.

1.10 ALTERNATIVES

- A. Alternative insulations are subject to Architect's approval. Alternatives shall provide, at normal conditions, thermal resistance within 5% of resistance of materials specified.
- B. Where alternative thermal conductivity ("k") differs from specified thermal conductivity by more than 5%, increase or decrease insulation thickness as follows:

$$\text{New thickness} = \frac{\text{Actual "k"}}{\text{Specified "k"}} \times \text{specified thickness}$$

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armstrong World Industries
3. Owens-Corning Fiberglass
4. Knauf Insulation
5. Certain Teed

B. Insulation Type P1:

1. Piping: Fine fibrous glass insulation, with factory applied vapor barrier jacket, molded to conform to piping, "k" value at 75° F. maximum 0.23. Johns Manville "Micro-Lok AP-T Plus" with jacket of white Kraft reinforced with fiberglass yarn and bonded to aluminum foil, and having a pressure sensitive tape closure system bonded to the longitudinal lap.
2. Valves and Fittings:
 - a. Glass fiber insert of equal thickness to adjacent pipe insulation and premolded PVC cover, Johns Manville "Zeston" and "Hi-Lo Temp Inserts" for valves and fittings.
 - b. Factory molded fibrous glass fitting covering for fittings of equal thickness to adjacent pipe insulation. Cover with 6 ounce canvas on concealed piping and 8 ounce canvas on exposed piping.
 - c. Mitered sections of pipe covering for valves.

C. Insulation Type P2:

1. Piping: Type P1 with additional PVC jacket Zeston 2000 PVC or equal with minimum thickness of 0.030 inches. Seal with permaweld adhesive.
2. Valves and Fittings: Mitered sections of Type P2 piping insulation with miter seals and snap-straps.

D. Insulation Type P3: Piping, Valves and Fittings: Foamed plastic of closed cell structure, "k" value at 75° F. maximum 0.27. Maximum water vapor transmission rating of 0.1 perms. Insulation shall not drip or melt when exposed to flame. Polyethylene or polyolefin not allowed. Armacell "AP Armaflex", "AP Armaflex SS" and "SSA-2000" (maximum 0.2 perms). Exposed insulation in finished areas shall be white.

E. Insulation Type P4: Piping, Valves and Fittings: Asbestos free hydrous calcium silicate colored gold throughout, molded to conform to piping, "k" value at 200° F. and 500° F. maximum 0.42 and 0.50 Btu/in./sq.ft./° F./hr. respectively. Johns Manville "Thermo-12 Gold" throughout.

F. Insulation Type P5 Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-

retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Determine clearances required for installation of work and review such requirements with trades responsible for installing various piping systems, and equipment to be insulated. Where it is determined that working clearances between equipment and material to be insulated and adjacent work will restrict or prohibit proper installation of work, immediately report such conditions to all interested parties and arrange to have affected material relocated or preinsulated before erection, as approved. Failure to so comply will not relieve Contractor of full responsibility for providing specified insulation.
- B. Do not install covering before piping, and equipment has been tested and approved.
- C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with applicable requirements of Division 22 Section, "Common Materials and Methods for Plumbing".
- B. Adhesives and mastics materials shall be compatible with insulation material, jackets and substrates. Apply insulation and adhesives in accordance with manufacturers' instructions.
- C. Do not install any insulation before building is adequately closed in. Where it is necessary to install insulation in any section of building that is not adequately closed in, secure prior permission and, where permission is granted, such insulation shall be in place to form a waterproof covering. Remove and replace all insulation installed that becomes water saturated because of failure to comply with this requirement, at no increase in the Contract sum.
- D. Clean excess adhesive, mastic or cement used in performance of work from all exposed surfaces of insulation jacketing materials. Clean smudges and dirt from all exposed surfaces of insulation jacketing materials at conclusion of this work.
- E. Apply insulation on all cold surfaces with a continuous, unbroken vapor seal. Install hangers outside of insulation for all piping subject to sweating (e.g., domestic water piping, chilled drinking water piping, cold USP water piping) and provide inserts - refer to and coordinate with Section 22 05 00, Part 3, Article titled "PIPING SYSTEMS – COMMON REQUIREMENTS", paragraph titled "Pipe Insulation Inserts and Shields". For all equipment subject to sweating, insulate and vapor seal hangers, supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.
- F. Extend all surface finishes to protect all surfaces, ends and raw edges of insulation.

- G. Install insulation on and at access doors to allow easy use of access door without damage to insulation.
- H. Finish insulation neatly at hangers, supports and other protrusions.
- I. Install insulation with least number of joints practical. Locate insulation, or cover seams, in least visible locations.
- J. Finish installation with systems at operating conditions. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- K. Be responsible for proper curing of insulation, etc., in accordance with manufacturers' requirements.
- L. Repair existing insulation damaged through installation of new work to match existing insulation.

3.3 PENETRATIONS

- A. Refer to Division 22 Section "Common Materials and Methods for Plumbing" for additional requirements.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07. Coordinate requirements for sleeves and clearance between finished surface of penetrating item and penetrated construction to achieve proper installation of through-penetration fire-stop system.
- C. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Carry pipe insulation through sleeves and through hangers which are specified to be installed outside insulation.
- C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings 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.
3. 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.
 4. 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.
 5. 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.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
 10. Do not insulate flexible connections and expansion joints. Install insulation on flanges, valves and unions so that it can be removed and replaced without damaging adjacent insulation.
- D. Strainers, temperature control valves, safety valves, relief valves, flanges and unions in hot piping 3/4 inch and smaller in size in equipment rooms and 1 inch and smaller in size elsewhere. Finish insulation neatly at flanges, leaving space for access to both.
- E. Terminate insulation neatly and finish all exposed ends with plastic material troweled on bevel.
- F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- G. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

H. Insulation Type P1

1. Seal longitudinal laps of jackets and wrap butt joints with 3 inch wide strip of jacketing material securely sealed in place.
2. Where premolded PVC fitting covers are used, apply factory precut insulation insert in accordance with manufacturer's instructions and then apply one piece cover. Use two or more layers of inserts on hot piping as required to limit outer surface temperatures of insert(s) to 150° F. maximum. On concealed hot piping, covers may be secured with staples. On exposed hot piping, secure covers by taping ends to adjacent insulation. Seal seam edges of covers on concealed and exposed cold piping with Zeston vapor-barrier adhesive and wrap edges of covers with Zeston vapor-barrier pressure sensitive color matching tape.
3. Where factory-molded fibrous glass fitting covering is used, finish insulation on concealed and exposed hot piping with same jacketing material as adjacent insulation lap-sealed and finished with Foster 30-36, Childers CP-50A or equal. Finish insulation on cold piping same as for hot piping except that sealer shall be Foster 30-35 or Childers CP-30LO vapor sealer.
4. Finish valve covering in hot and cold piping systems same as specified above for fittings.
5. Recover exposed piping in finished areas with 0.02 mil thick PVC jacket less than 8 ft. above floor in mechanical room, with 0.02 mil thick PVC jacket or aluminum jacket, except use Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, adhered and then finished with Foster 30-36 or Childers CP-50A at steam pressure reducing stations and when piping systems are specified to be painted.

I. Insulation Type P2

1. Secure PVC jacket in place by a continuous longitudinal solvent weld type joint.
2. Use mitered sections of PVC jacketed insulation for valves and fittings. Seal joints with solvent weld compound
3. Entire installation of PVC jacketed insulation shall be weatherproof.

J. Insulation Type P3

1. Where possible, slip insulation over tubing as a full cylinder. Where necessary to cut and at all butt joints, tightly butt edges and join by sealing with waterproof vapor barrier adhesive,

Armstrong 520. For Self-Seal type, peel adhesive paper from surface and apply firm pressure along entire longitudinal joint.

2. Cover fittings and valves with equivalent thickness of insulation material.
3. Finish outdoor insulation with two coats of manufacturer's recommended weather-resistant and ultraviolet-resistant protective finish: Armacell WB Armaflex, white. DO NOT TINT FINISH.
 - a. At Contractor's option for exposed indoor piping and for all outdoor piping, use aluminum jacket, as specified for insulation Type P-2.
 - b. Secure metal jacket in place by a continuous longitudinal friction type joint. Seal circumferential joints with 2 inch wide, .016 inch aluminum preformed snap-strap and clip containing a permanently plastic weatherproof sealant. Where outside diameter of the insulation is over 12-3/4 inch, lock snap-strap in place using 3/4 inch wide, .015 inch thick, No. 302 stainless steel bands. Apply snap-strap with appropriate banding wrench.
 - c. Use mitered sections of metal jacketed insulation for valves and fittings. Seal joints with sealing compound and preformed aluminum bands.
 - d. Entire installation of outdoor piping shall be weatherproof.

3.5 PIPING INSULATION SCHEDULE

A. Thickness Schedule (TS)

TABLE 1				
Plumbing and Drainage				
Minimum Insulation Thickness for Pipe Sizes*				
Schedule No.	Water Temp. Range	1-1/4 In. and Less	1-1/2 to 8 In.	Over 8 In.
	Deg F.	in.	in.	in.
TS-11	105-140	1.0	1.5	1.5
TS-12	40-60	0.5	1.0	1.0
*Refer to Article titled "Alternatives".				
*Comply with ASHRAE 90.1 - 2016				

B. Type: Unless otherwise specified use Insulation Type P1 on indoor piping and Insulation Type P2 on outdoor piping, except as follows:

1. Contractor may substitute Type P3 of thickness as scheduled for Type P1 or P2 when system operating temperature is less than 210 deg F. and specified thickness is 1/2 inch or less.
2. Contractor may substitute Type P3 of thickness as scheduled for Type P1 or P2 when system operating temperature is less than 210 deg F. and:
 - a. Piping is constructed from rolls of soft copper tubing and space limitations preclude straightening of tubing to allow satisfactory installation of Type P1 or P2.

SECTION 22 10 00 - PLUMBING SYSTEMS

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 plumbing materials and equipment for domestic water, fuel gas and drainage systems:

- 1. Pipe and fittings
- 2. Valves

- B. Related Sections include the following:

- 1. Section 22 11 00: Disinfection of Domestic Water Lines
- 2. Section 22 05 00: Basic Materials and Methods
- 3. Section 22 07 00: Plumbing Insulation
- 4. Section 22 05 13: Electrical Equipment and Wiring for Plumbing Systems
- 5. Section 22 40 00: Plumbing Fixtures and Trim
- 6. Section 21 00 00: Fire Suppression
- 7. Division 25: Integrated Automation
- 8. Division 26: Electrical

1.3 REFERENCES

- A. AGA - Installation of Gas Appliance and Gas Piping
- B. ASME A112.26.1M, ASSE 1010, PDI - WH201 - Water Hammer Arresters
- C. ASME - Boiler and Pressure Vessel Code
- D. ASSE 1018 - Trap Seal Primer Valves, Water Supply Fed
- E. ASTM C478 - Precast Reinforced Concrete Manhole Sections
- F. NEMA MG-1 - Motors and Generators
- G. IFC, International Fuel Gas Code
- H. NFPA 54, National Fuel Gas Code

- I. NFPA 58, Liquefied Petroleum Gas Code
- J. NFPA 70 - National Electrical Code
- K. AGA - Plastic Pipe Manual for Gas Service
- L. Commonwealth of Pennsylvania Department of Labor & Industry Regulations Governing Boilers and Unfired Pressure Vessels
- M. API/1615 - Installation of Underground Petroleum Storage Systems
- N. EPA/530/UST-88/008 Regulations for Underground Storage Tank Systems
- O. ASCE/SEI 7 - Seismic Performance Criteria
- P. NSF 61 - Standard for Potable Domestic Water Piping and Components

1.4 SUBMITTALS

- A. Product data for the following:
 - 1. Pipe, valves and fittings
 - 2. Drains, cleanouts and trap primers
 - 3. Water heating equipment
 - 4. Backflow preventers
 - 5. Meters
 - 6. Mixing valves/high temperature alarm
 - 7. Pressure regulators
 - 8. Fabricated steel or cast iron grease and oil interceptors
 - 9. Waste oil storage tank
 - 10. Gas boosters
- B. Shop drawings showing fabrication and installation details.
 - 1. Precast concrete manholes
 - 2. Precast concrete grease interceptors
 - 3. Precast concrete oil interceptors
 - 4. precast concrete decontamination tanks
 - 5. Precast concrete meter pits
- C. Welding certificates.

1.5 WARRANTY AND CONTRACT CLOSEOUT

- A. Warranty
 - 1. Refer to BIDDING AND CONTRACT REQUIREMENTS and to warranty and contract closeout requirements specified in DIVISION 00

B. Contract Closeout

1. Comply with requirements of Division 1, Contract Closeout.
2. Include information for all products specified in this section, in the operating and maintenance manual.
3. Provide the following as specified in this section or Section 22 05 00.
 - a. Testing and cleaning reports certified by contractor for each system.
 - b. Balancing report for domestic hot water recirculation system. Include certificate stating degree of accuracy of instruments.
 - c. Portable flow measuring instrument for automatic flow control valves.
 - d. Insurance inspection certificate for direct fired storage domestic water heater.
 - e. Inspection form U-1 for compact type domestic hot water generator.
 - f. Qualification certificates for plastic piping system installers/solvent welders.

1.6 ENERGY PERFORMANCE CRITERIA

- A. Rating temperatures and conditions, Coefficient of Performance (COP) and Energy Efficiency Rate (EER) of all equipment and components provided under this section shall meet the requirements of the State Energy Code or latest issue of ASHRAE Standard 90.1, or of the latest issue of the Standards for Equipment in the National Energy Policy Act, whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of the following manufacture:
 1. Pipe and Fittings
 - a. General Pipe and Fitting Materials, No Specified Manufacturer
 - 1) Any manufacturer whose products are manufactured in the United States and comply with the reference standards.
 - b. Basic Pipe and Fitting Materials and Accessories not Specified in this Section: Refer to Section 22 05 00.
 2. Valves
 - a. Basic Valve Types not Specified in this Section: Refer to Section 22 05 00.
 - b. Type V14, Ball Check Valve
 - 1) Flygt
 3. Water Hammer Arrestors

- a. Josam
- b. J. R. Smith
- c. Precision Plumbing Products
- d. Sioux Chief
- e. Wade
- f. Zurn
- g. Watts Drainage

2.2 PIPE AND FITTINGS

A. General

1. Pipe and fitting materials and joint types are specified in the following "Piping Class" paragraphs. Application material and joint type which will be permitted for specific services are specified hereinafter in the Article titled "Piping System Requirements". Where more than one Piping Class is listed under "Piping System Requirements" for a service, use any of listed classes, unless otherwise specified or indicated, but systems' materials must be consistent throughout the work.
2. Pipe and fittings shall conform to the latest issue of the standards referred to hereinafter. Each length of pipe and each fitting shall be marked with the manufacturer's name brand and specification code designation to which it belongs.

B. *Piping Class CI2

ITEM	LIMITS	DESCRIPTION
PIPE & FITTINGS	2 inch thru 12 inch	Cast iron no hub soil pipe and fittings
JOINTS	2 inch thru 12 inch	Compression type couplings similar to Tyler Corporation "CI No-Hub Couplings" CISPI 310 Clamp All Hi Torq 125, Mission, Husky or equal]

* For use only above ground where allowed by codes.

Reference Standards

1. Cast Iron Soil Pipe and Fittings, No Hub: ASTM A888, CISPI 301. Joints, ASTM C564. Piping shall bear CISPI collective trademark and NSF international listing.

C. Piping Class CU1 & CU1S

ITEM	LIMITS	DESCRIPTION
PIPE	All sizes	Copper tubing Type L. Hard temper for Class CU1 and soft temper for Class CU1S
JOINTS	All sizes	Soldered
FITTINGS	All sizes	Wrought copper, except cast brass only in sizes where wrought copper is not available

UNIONS	2 inch and smaller	Class 200
	2-1/2 inch and larger	Companion flanges
FLANGES	2-1/2 inch and larger	Class 150 cast bronze

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. Soldered Fittings for Copper Tubing: Wrought copper, ANSI B16.22 for pressure fittings and B16.29 for drainage fittings; Cast brass for larger sizes where wrought copper is not available, ANSI B16.18 for pressure fittings and B16.23 for drainage fittings.
3. Flanges for Copper Tubing: Cast bronze, ANSI B11.24, Classes 150 and 300, solder joint.

Alternate Jointing and Fitting System may be used in lieu of requirements above as follows:

4. Press Fit System, Apollo Xpress, Nibco, Viega

Installation shall be in accordance with manufacturer's instructions.

D. Piping Class CU1M

ITEM	LIMITS	DESCRIPTION
PIPE	2-6 inch	Copper tubing Type L. Hard temper
JOINTS	2-6 inch	Soldered or roll grooved mechanical coupling
FITTINGS	2-6 inch	Wrought copper, except cast brass only in sizes where wrought copper is not available
UNIONS	2-6 inch and larger	Companion flanges
FLANGES	2-6 inch	Class 150 cast bronze

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. Soldered Fittings for Copper Tubing: Wrought copper ANSI B16.22; Cast brass for larger sizes where wrought copper is not available, ANSI B16.18.
3. Copper Grooved-End Fittings: ASTM B75 or ASTM B584.
4. Flanges for Copper Tubing: Cast bronze, ANSI B11.24, Classes 150 and 300, solder joint.
5. Refer to Section 22 05 00 for mechanical couplings.

Alternate Fitting/Jointing System installed in accordance with manufacturer's instructions may be used in lieu of requirements above as follows:

1. T-Drill System - Formed tee ASTM 2014
2. Press Fit System, Apollo Xpress, Nibco, Viega

E. Piping Class CU2

ITEM	LIMITS	DESCRIPTION
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PIPE	2 inch and smaller*	Copper tubing, Type K, soft, in rolls
JOINTS	2 inch and smaller*	Soldered except flared at valve, underground branch and equipment connections
FITTINGS	2 inch and smaller*	Wrought copper for soldered, cast bronze for flared
UNIONS	2 inch and Smaller	Class 200, for soldered joint piping
*NOTES:	1. No joints allowed for lengths under: 95 foot for 1-1/4 inch and smaller 55 foot for 1-1/2 inch 40 foot for 2 inch 2. No underground joints allowed below floors, driveways and the like.	
EXCEPTIONS:	Where branches are required underground, flared connections are to be used.	

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. Soldered Fittings for Copper Tubing: Wrought copper ANSI B16.22; Cast brass for larger sizes where wrought copper is not available, ANSI B16.18.
3. Flared Fittings for Copper Tubing: Cast bronze, ASTM B62, ANSI B16.26.

F. Piping Class CU3

ITEM	LIMITS	DESCRIPTION
PIPE	Less than 1-1/4 inch	Copper tubing, Type L, Hard
	1-1/4 inch & larger	Urinals (2") copper tubing Type K, hard; elsewhere DWV copper drainage tubing and fittings, hard.
JOINTS	All sizes	Soldered
FITTINGS	All sizes	DWV Pattern wrought copper except cast brass only in sizes where wrought copper is not available
FLANGES		Class 150 cast bronze

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. DWV Copper Drainage Tube: ASTM B306, ANSI H23.6.
3. Flanges for Copper Tubing: Cast bronze, ANSI B11.24, Classes 150 and 300, solder joint.
4. Soldered Drainage Fittings (DWV): Cast bronze, ANSI B16.23.
5. Soldered Fittings for Copper Tubing: Wrought copper ANSI B16.29; Cast brass, for larger sizes where wrought copper is not available, ANSI B16.23.

2.3 PIPING SYSTEM REQUIREMENTS

Service	Valve Type/Class	Pipe Class
Domestic Water Above Ground 1) General Service 6 inches and smaller	VC-4	CU1, CU1M
Sanitary and Combination Storm and Sanitary Gravity Drainage and Vent Above Ground 1) Piping, General 2) Branch Waste & Vents for Fixtures other than Water Closets and Urinals 3) Branch Waste & Vents for Water Closets 4) Branch Waste & Vents for Urinals (2 inch) 5) Indirect drainage 6) Exposed Piping at Fixtures & Equipment *If allowed by codes. If not allowed, use CU3. **Piping less than 1-1/4 inch in size		CI1, CI1, CU3 CI1 PVC3* CU1**, CU3 BR1

2.4 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 22 to assure that all general service valves throughout the work of Division 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for Classes 200 and 300, copper-silicon bronze stem.
5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.
6. All valves used in domestic water applications shall comply with NSF/ANSI 61 for lead free construction.

- B. Refer to Section 22 05 00 for specifications for basic valve types not specified in this section.

C. Type V14 Ball Check Valve: Nonclog, unobstructed, free flow type. Ball shall be out of the flow in the open position, directed to and from the body seat by guide rails integral with the valve body. Function satisfactorily in a vertical, horizontal or inverted position. Capable of direct burial without the use of a vault or other enclosure. Ball actuated by the flowing medium, system pressure, or gravity without the use of springs, levers, weights or external power source. Body of gray cast iron construction for sizes 2-1/2 inch and larger, flange ends integral with the body casting, flat faced and drilled to ANSI B16.1, Class 125 cast iron, standard. Body shall be cast bronze with threaded connections conforming to N.P.T. for 2 inch size. Ball shall be a hollow steel sphere with a smooth covering of nitril rubber. Valve shall be suitable for 150 psig working pressure and a temperature of 185°F. Flygt HDL ball check valves.

D. Valve Classes

1. Valve Class VC-4

SERVICE	LIMITS	ALLOWABLE VALVE TYPES
SHUTOFF	Copper Tubing	V8a, V9\ V10
	Steel Pipe	V8a, V9, V10
THROTTLING (BYPASS)	Copper Tubing	V1 & V4 globe, V9, V10
	Steel Pipe	V2 & V4 globe, V9, V10
BALANCING		Calibrated type Class 125 bronze body. Bell & Gossett circuit setter or equal. See Section 20 05 00.
CHECK	Copper Tubing	V1 swing check or V14 at storm water or sanitary pump discharge, V1 & V4 elsewhere
	Steel Pipe	V2 swing check or V14 at storm water or sanitary pump discharge, V2 & V4 elsewhere
*Not allowed for pump discharge balancing service.		

2.5 WATER HAMMER ARRESTERS

A. ASME A112.26.1M, ASSE 1010, or PDI-WH 201, stainless steel bellows with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M sizes A through F and PDI-WH 201 sizes A through F. Piston type are not permitted for applications that exceed 60 psi.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Refer to and comply with Section 22 05 00 for basic requirements.
- B. Refer to Section 22 05 48 for vibration isolation and seismic restraints, penetration seals and the like.

3.2 CLEANING OF SYSTEMS

- A. Refer to Section 22 05 00 for basic requirements.
- B. Disinfect domestic hot and cold water distribution systems in accordance with latest issue of American Water Works Association Standard C651.

3.3 CLEANOUTS

- A. Provide cleanouts on all drainage piping at 50 foot intervals on piping 4 inches and smaller and at not more than 100 foot intervals on larger pipe sizes, at each change in direction of more than 45°, at the base of drainage stacks and at other locations shown. Cleanouts full size for pipes up to 4 inches and not less than 4 inches for larger pipes except where code requires cleanouts larger than 4 inches. Cleanout sizes shall comply with applicable plumbing code.
- B. Install cleanouts in driveways and yards flush with top of a 16 inch by 16 inch by 8 inch concrete pad set flush with grade or road. Where cleanouts are provided in vitrified clay below ground, last 5 foot length of vertical riser shall be cast iron.
- C. Lubricate non-plastic cleanout plugs with mixture of graphite and linseed oil or provide Teflon tape on threads. Sealants for plastic cleanout plugs shall be compatible with plastic piping materials. Prior to building turnover remove cleanout plugs, relubricate and reinstall using only enough force to ensure permanent leakproof joint.

3.4 DOMESTIC WATER PIPING

- A. Install inside domestic water distribution piping with sufficient pitch and in a manner that entire system may be drained at a central point, if possible. Otherwise provide drainage points for each portion of system.
- B. Support risers and stacks by metal brackets attached to building construction or by other approved methods.
- C. Provide a riser shutoff valve at all water supply risers in nearest accessible location.
- D. For each toilet room with two or more plumbing fixtures provide shutoff valves on hot and cold water supply piping within access panel or other accessible location.
- E. For domestic hot water recirculating systems, manually adjust calibrated type balancing valve to provide flow of hot water in each branch with flow rates selected for a maximum temperature drop of 5° F.

- F. Provide 3/4 inch tap with hose end valve for pipe disinfection where water main enters building downstream of backflow preventer.
- G. Provide isolation valve in new piping where new piping and existing piping interconnect. Provide 3/4 inch tap with hose end valve for pipe disinfection downstream of isolation valve.

3.5 ELECTRICAL WORK

- A. Refer to Section 22 05 00 for general requirements.

3.6 PIPING CONNECTIONS

- A. Refer to Section 22 05 00 for basic requirements.
- B. Bell and Spigot, Cast Iron Pipe Joints: Caulk firmly with oakum or hemp and fill with molten lead not less than 1 inch deep and not to extend more than 1/8 inch below rim of hub; no paint, varnish or other coatings permitted on jointing material until after joint has been tested and approved. Neoprene gasketing system or gasket and clamp type mechanical fastener where specified.

3.7 SANITARY, STORM AND ACID RESISTANT DRAIN PIPING

- A. Set true to line and even slope using grade boards and targets or grade lines. Install cast iron soil pipe and fittings and make joints in accordance with "Cast Iron Soil Pipe & Fittings Handbook".
- B. Slope suspended sanitary and storm piping downward minimum 1/4 inch per foot where possible for pipes 3 inch and smaller, and 1/8 inch per foot for piping 4 inch diameter and larger, and in all cases, conform to code requirements.
- C. Slope underground sanitary and storm piping downward a minimum of 1/4 inch per foot for 3 inch pipe and less; a minimum of 1/8 inch per foot for piping larger than 3 inch diameter, and in all cases, conform to code requirements.
- D. Install all piping in accordance with manufacturer's recommendations regarding connections, hangers, hanger spacing, underground installation, etc. Support suspended horizontal soil pipe near each hub, with maximum spacing between hangers of 5 feet for pipe fabricated in 5 foot lengths and 10 feet for pipe fabricated in 10 foot lengths. Underground PVC piping shall be installed in accordance with ASTM D2321 latest edition. Provide sway braces and anchorage on horizontal drainage piping sizes 5" and larger at changes of direction, where required by code and/or where recommended by coupling manufacturer and or CISPI standard 4 inch pipe size. Shall be included when required by the plumbing code.
- E. Provide main trap with fresh air inlet for each sanitary and storm main drain line.
- F. Provide deep seal trap at base of each vertical rainwater conductor.

- G. For corrosive soil conditions, metallic underground piping shall be provided with loose polyethylene encasement 0.008" thick.
- H. Provide ball joint connections at foundation wall where piping exists building, EBAAron flex-tend or equal.
- I. Support underground piping from structural floor slab. Refer to detail on drawings.

3.8 TESTING OF PIPING SYSTEMS

- A. Refer to Testing of Piping Systems, General in Section 22 05 00.
- B. Field Quality Control
 - 1. Do not enclose, cover, or put into operation water distribution piping system and drainage and vent piping system until each has been inspected and approved by the authority having jurisdiction.
 - 2. Reinspections: When the representative of the authority having jurisdiction finds that piping system will not pass test or inspection, make required corrections and arrange for reinspection by authority having jurisdiction.
 - 3. Reports: Prepare inspection reports signed by the representative of the authority having jurisdiction.
 - 4. Test in accordance with the more stringent of the requirements of the authority having jurisdiction or the following:
- C. Gravity Drainage Systems
 - 1. Combination Water/Air Test
 - a. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open-jointed drain tile, test new and/or altered piping of plumbing drainage and venting systems on completion of roughing in piping installation. Tightly close all openings in piping system and fill with water to point of overflow, but not less than 10 feet head of water. Limit test pressure on plastic piping system to 30 feet head of water maximum. Water level shall not drop during the period from 15 minutes before inspection starts through 15 minutes after completion of inspection. Inspect all joints for leaks.
 - b. Finished Plumbing Test Procedure: After plumbing fixtures have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves the building and introduce air into the system equal to pressure of 1 inch water column. Use a U tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period beginning 15 minutes before inspection starts and 15 minutes after completion of inspection. Inspect plumbing fixture connections for gas, air and water leaks.
 - 2. Air test only

- a. Rough Plumbing Test Procedure: If tests are made with air, apply a pressure of not less than 5 psig with a force pump and test as specified above. Use mercury-column gauge registering 10 inches in height in air test. Use air tests only when air temperatures around tested system are 32° F. or below and temporary heat is not available.
 - b. Finished Plumbing Test Procedure: Test as specified above.
- D. Domestic Hot and Cold Water: Test hydrostatically upon completion of the rough-in and before insulating or setting fixtures. Maintain pressure for not less than 4 hours without leakage.
- E. Unless otherwise required by Code, new branch piping connected to existing systems may be tested at normal operating pressure, provided new piping does not exceed 75 feet, or does not include more than 20 fittings.

3.9 VALVES

- A. Refer to Section 22 05 00 for basic requirements.
- B. Equip each main and each major branch valve in Boiler Mechanical Room installed in a line over 7 feet above floor with appropriate size babbitt adjustable sprocket rim, chain and chain guide. Continuous chain shall reach within six feet of floor. Use only valves available with chain operators. Install with wheel in vertical plane.
- C. Provide gate valves 8 inch and larger on high pressure (above 100 psig) water lines with built-up valved bypasses conforming to MSS-SP45, Series A, for iron body valves; bypasses on steel valves furnished with drop forged steel, OS&Y bolted bonnet globe valves with socket weld ends. Bypass valves shall have trim materials for same service as main valve.

3.10 WATER HAMMER ARRESTERS

- A. Provide water hammer arresters at ends of all branches in hot and cold supply piping, at each group of flush valve operated fixtures, at equipment having quick closing valves (such as washers) and elsewhere as required and/or indicated on Drawings. Size and install each arrester according to manufacturer's instructions. Where pressure exceeds 60 psi, use next size larger where required by unit manufacturer. Install in an upright position and above ceiling in pipe chase in an accessible location.

END OF SECTION 22 10 00

SECTION 22 11 00 - DISINFECTION OF DOMESTIC WATER LINES

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 disinfection and laboratory testing of domestic water piping systems to certify disinfection of system.
- B. Related Sections: Division 22.

1.3 DEFINITIONS

- A. Disinfectant Residual means the quantity of disinfectant in treated water.
- B. pH Factor means the measure of alkalinity and acidity in water.
- C. Ppm means parts per million.
- D. CFU/mL means colony forming units per milliliter.

1.4 QUALITY ASSURANCE

- A. Water Treatment Contractor: At least 5 years' experience performing Work specified herein.

1.5 REFERENCE STANDARDS

- A. AWWA Specification C-651 - Disinfecting Water Mains.
- B. Centers for Disease Control and Prevention (CDC) Standard Methods #9260J.

1.6 SUBMITTALS

- A. Water Treatment Contractor's evidence of certification: Submit four copies.
- B. Water Treatment Contractor's evidence of experience: Submit four copies.
- C. Tests Reports: Submit four copies as follows:

1. Disinfection Report, include:
 - a. Date issued
 - b. Project name and location
 - c. Treatment Contractor's name, address, and phone number and name of person executing disinfection
 - d. Type and form of Disinfectant used
 - e. Time and date of Disinfectant injection start and completion
 - f. Test Locations
 - g. Initial and 24 hour Disinfectant Residuals in ppm for each outlet tested
 - h. Time and date of flushing start and completion
 - i. Disinfectant Residual after flushing in ppm for each outlet tested

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect against damage and contamination.
- B. Maintain caution labels on hazardous materials.
- C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg F. and 80 deg F.

1.8 PROTECTION

- A. Provide necessary signs, barricades and notices to prevent any person from accidentally consuming water or disturbing system being treated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Disinfectant:
 1. Sodium Hypochlorite; liquid, powder, tablet, or gas.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to starting Work verify that domestic water system is completed and cleaned.
- B. Notify General Contractor about defects requiring correction.
- C. Do not start Work until conditions are satisfactory.

3.2 SYSTEM TREATMENT

- A. Inject Disinfectant to obtain 200 ppm residual throughout the system.
- B. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.
- C. Maintain disinfectant in system for 3 hours.
- D. At the end of retention period, test for Disinfectant Residual at each of the following locations:
 - 1. Ends of piping runs
 - 2. Remote outlets
 - 3. Tanks
 - 4. At least 15% of outlets on each floor where directed by Architect, but in no case less than 2 outlets
- E. If Disinfectant Residual is less than 10 ppm, repeat system treatment.

3.3 FLUSHING

- A. Remove disinfectant by flushing system with clean water until residual rate is reduced to less than 1.0 ppm.

3.4 LEGIONELLA TEST

- A. Instruct bacteriological laboratory to take water samples no sooner than 24 hours after flushing system.
- B. Take water samples at each of the following locations:
 - 1. Domestic water heater drain valve
 - 2. Ends of piping runs
 - 3. Remote outlets
- C. Analyze water samples in accordance with CDC Standard Method #9260J, or other internationally recognized test method as recommended by groups such as Special Pathogens Laboratory of the VA Medical Center, Pittsburgh, Pennsylvania.
- D. Samples shall be delivered to the laboratory and analyzed within 48 hours of collection. Samples shall be protected from extreme temperature variations during transport.
- E. Sample collection: Collect samples utilizing the methodology described as follows:
 - 1. Faucets: Moisten the outlet by allowing water to trickle through the opening. A sterile Dacron swab is inserted and rotated four times around the inner circumference and moving up the faucet as far as the swab will reach. Replace the swab into the container. If the swab system does not contain a transport medium, then allow 0.5 ml of water to flow from the faucet into the container to keep the swab moist. The Cultiurette II System

(Becton Dickinson) has a self-contained transport medium, and it is not necessary to add outlet water to the swabs.

2. Shower Head: Moisten the shower head by allowing water to trickle through the opening. Rotate the swab over the entire surface of the shower head 4 times. Place swab into the container. If the swab system does not contain a transport medium, then allow 0.5 ml of water to flow from the shower head into the container.

F. Action Limits: Test results indicating the Legionella CFU/mL shall be acted upon as follows:

1. Individual Sample Test of less than 10 CFU/mL: Report results with recommendation for monthly follow-up testing. After 6 months of follow-up testing with no test above 10 CFU/mL, testing may be suspended. If samples from 30% or more of tested outlets test positive for Legionella, report results with recommendation for prompt cleaning and/or biocide treatment.
2. Individual Sample Test Result Between 10 and 99 CFU/mL: Report results with recommendation for prompt cleaning and/or biocide treatment.
3. Individual Sample Test Result of 100 CFU/mL or Higher: Report results and recommend immediate cleaning and/or biocide treatment with prompt steps to avoid exposure.

3.5 ALTERATIONS TO EXISTING SYSTEMS

- A. Unless required otherwise by Codes or authorities having jurisdiction, new branch piping not exceeding 75 total linear feet that is connected to existing systems need not be disinfected. Thoroughly flush this piping with system water and then test for coliform and Legionella organisms. If tests indicate presence of coliform organisms, or Legionella organisms, treat piping as described above and retest for coliform and Legionella. Provide all necessary valves, drains, piping and accessories required to isolate new piping from existing systems during treatment.

END OF SECTION 22 11 00

SECTION 22 40 00 - PLUMBING FIXTURES 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. This section is intended to describe the plumbing fixtures and devices for the plumbing work.
- B. This section includes the following:
 - 1. Plumbing fixtures and trim
 - 2. Miscellaneous plumbing accessories
- C. Related sections include the following:
 - 1. All applicable sections of Division 1
 - 2. Division 7: Sealants
 - 3. Section 22 05 00: Basic Materials and Equipment
 - 4. Section 22 10 00: Plumbing Systems

1.3 REFERENCES AND REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

- A. Provide work in accordance with all applicable codes, rules, regulations and reference standards.
- B. ANSI - Z358.1 - Latest Edition: American National Standard for Emergency Eyewash and Shower Equipment.
- C. NSF/ANSI 61: Drinking Water System Components.
- D. LEED - NC2.2 - Leadership in Energy and Environmental Design - New Construction Version 2.2.

1.4 SUBMITTALS

- A. Provide submittals for all products listed in Article 2.01 of this section in accordance with Section 01 33 00, Submittal procedures in sufficient detail to verify full compliance with the requirements of the contract documents.

- B. For each plumbing fixture category and type specified, include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment and supports. Indicate materials and finishes, dimensions, construction details and flow-control rates.
- C. Submit wiring diagrams from manufacturer for electrically operated units.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver plumbing fixtures in manufacturer's protective packing, crating and covering.
- B. Store plumbing fixtures on elevated platforms in dry location.

1.6 WARRANTY AND CONTRACT CLOSEOUT

- A. Comply with warranty and contract closeout requirements specified in Division 00.
- B. Warranty
 - 1. Refer to BIDDING AND CONTRACT REQUIREMENTS and to DIVISION 1 - GENERAL REQUIREMENTS. In addition, provide the following extended warranties as specified in this section:
 - a. Five year warranty on electric water cooler refrigerationsystem.
 - b. Three year nonprorated warranty on flush valves.
- C. Contract Closeout
 - 1. Include information for all products specified in this section, in operating and maintenance manual.

1.7 PROJECT/SITE CONDITIONS

- A. Coordinate roughing in and final fixture locations and verify that plumbing fixtures can be installed in accordance with contract documents.
- B. Check millwork Shop Drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.8 QUALITY ASSURANCE

- A. Provide fixtures described herein. All trim shall be manufacturer's first grade line, perfect in all respects. "Competition" or "Reserve Grade" material will not be accepted. Manufacturers and model numbers listed are to indicate standard of quality. Equal products of acceptable manufacturers listed in Article 2.01 may be submitted for review.
- B. Faucets, fittings, handles, traps, seat hinges, water and waste connections, and any other exposed parts shall be polished chrome plated brass. Provide chrome plated escutcheons for all

exposed plated piping penetrating floors and walls. The metal used in castings shall be red metal, having a copper content of not less than 85% and tubing used at plumbing fixtures, heavy seamless brass tubing, not less than No. 17 gauge.

- C. Fixtures shall be product of one manufacturer.
- D. Fittings of same type shall be product of one manufacturer.

1.9 GENERAL REQUIREMENTS

- A. Plumbing fixtures shall be white, unless indicated otherwise.
- B. Provide supports for all wall mounted fixtures.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of the following manufacture:

- 1. Plumbing Fixtures (Water Closets, Urinals, Lavatories, Sinks and Baths)

- a. American Standard, Inc.
- b. Kohler Co.
- c. Zurn Industries
- d. Crane
- e. Elkay
- f. Just
- g. Toto
- h. Advance Tabco
- i. Franke

- 2. Flushometers

- a. Sloan Valve Co.
- b. Coyne and Delany Co.
- c. Zurn Industries, Inc.
- d. Toto

- 3. Toilet Seats

- a. Church Seat Co.
- b. Sperzel Industries, Inc.
- c. Beneke Corp.
- d. Olsonite Corp.
- e. Bemis Mfg. Co.

- 4. Electric Water Coolers

- a. Halsey Taylor
- b. Elkay Mfg. Co.
- c. Filtrine Mfg. Co., Inc.
- d. Oasis Water Coolers, Ebco Manufacturing Co.
- e. Sunroc, Inc.
- f. Haws

5. Brassware and Trim

- a. Speakman Co.
- b. American Standard, Inc.
- c. Kohler Co.
- d. Toto
- e. Chicago Faucet Co.
- f. Elkay
- g. T & S Brass
- h. Water Saver
- i. Delta Faucet Co.
- j. Sloan
- k. Zurn
- l. Moen Commercial

6. Traps and Supplies

- a. McGuire Manufacturing Co., Inc.
- b. Bridgeport Brass Co.

2.2 GENERAL

- A. All mixing valves, electronic faucets and faucets for service sinks and mop receptors shall have check valves or back checks installed in hot and cold water supply piping, branches or installed integral to faucet inlets.
- B. All supply stops for lavatories, sinks, etc. shall be of lead free construction complying with NSF/ANSI 61. All flex tube risers from stops to fixtures shall be chrome plated copper. Stops shall be all brass, no plastic. Braided flex risers are not permitted.

2.3 ELECTRIC WATER COOLERS

- A. All water coolers shall be NSF/ANSI 61 certified.
- B. Electric Water Cooler A (Wheelchair Type)
 - 1. Wall mounted, all stainless steel cabinet, stainless steel top and backsplash with a deep basin, antispash, chrome plated brass strainer, chrome plated brass bubbler with automatic stream control, valve operated by a bar in front panel.
 - 2. Cooling Unit: Hermetically sealed, air cooled condensing unit for 115 volts, 60 Hertz, single phase, lubricated for life and equipped with electric cord and three-prong molded rubber plug, thermostat with an adjustable range of 42° to 53° F., ARI certified,

- complying with Standard 1010-84. Provide five year warranty on the refrigeration system.
3. Refrigeration system shall employ high efficiency, positive start compressor, nonpressurized counterflow cooling coil with totally encapsulated EPS insulation and be controlled by positive sensing thermostat. Shall have front and side push-bar water controls with chrome plated raised lettering for the visually impaired. Cooler shall comply with ADA for both visual and motion disabilities. Cabinet shall have removable front panels. The manufacturer shall certify the unit to be lead free as defined by the Safe Drinking Water Act. Energy consumption not to exceed 400 watts/hr.
 4. Capacity and Manufacturer: To cool 8 gph water to 50° F. at 90° F. ambient, Halsey Taylor HAC-8FS-Q. Provide filter water Sentry HWF.172.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect fixtures against use and damage during construction.

3.2 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. At completion, thoroughly clean plumbing fixtures and equipment.
- C. Attach floor mounted water closets to floor with wax seal and lag screws. Do not use lead flashing to hold closet in place.
- D. Install faucets with wrist blades requiring "push to close". Wrist blades in the "closed" position should be 45° from the rear wall.
- E. Provide vacuum breakers for hose bibbs and faucets with hose connections.
- F. Securely bolt all fixtures to the building construction and unless special hangers are indicated, provide hangers and/or carriers designed specifically for the fixtures by the fixture manufacturer.
- G. Securely bolt all chair carriers/fixture supports to floor using 4 bolts in each foot of each support. All floor bolt openings in chair carriers to be used.
- H. Caulk all wall hung fixtures between fixture and wall with sealant specified in Section 07 92 00. Provide sealant at all points where mop receptor meets walls and floor.
- I. Install electric water coolers with "P" trap and water shutoff valve within cabinet.
- J. For ground hydrants, provide concrete mounting pad and minimum one cubic yard of crushed rock at base of hydrant.

SECTION 23 05 00 – COMMON MATERIALS AND METHODS FOR HVAC

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 is intended to describe the common materials and installation methods of the mechanical work and it applies in general to all other Sections under Division 23.
- B. Due to the small scale of the drawings, all work required is not shown on the floor plans and certain work is shown on flow diagrams, riser diagrams and details. Work of Division 23 shall include all required work shown on plans, riser diagrams, flow diagrams and details.
- C. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems
 - 2. Transition fittings
 - 3. Dielectric fittings
 - 4. Mechanical sleeve seals
 - 5. Sleeves
 - 6. Escutcheons
 - 7. Grout
 - 8. HVAC demolition
 - 9. Equipment installation requirements common to equipment sections
 - 10. Painting and finishing
 - 11. Concrete bases
 - 12. Hangers and supports for HVAC system piping and equipment
 - 13. Identification for HVAC Piping and equipment

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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.

1.4 REFERENCES

- A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:
 - 1. ASME/ANSI B31: Code for Pressure Piping
 - 2. ASME Boiler and Pressure Vessel Codes
 - 3. AWS D1.1: Structural Welding Code-Steel
 - 4. MSS SP58: Pipe Hangers and Supports – Materials, Design, and Manufacturers
 - 5. MSS SP69: Pipe Hangers and Supports – Selection and Application except spacing for hangers
 - 6. ANSI A13.1: Scheme for Identification of Piping Systems
 - 7. Applicable NFPA Codes and Standards

1.5 SUBMITTALS

- A. Provide Product List of factory fabricated items, in accordance with Section 01 60 00 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 23.
- B. Provide submittals in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.
- C. Product Data: Provide for each type of factory-fabricated product indicated.

1.6 WARRANTY AND CONTRACT CLOSEOUT

- A. Comply with warranty and contract closeout requirements specified in Division 00.
- B. Provide Special Warranties and/or warranty service in accordance with Section 01 60 00 “Product Requirements” where specified in the various sections of Division 23.
- C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 23.
- D. Provide testing and cleaning reports. Indicate dates of testing and cleaning operations, procedures used and results obtained for each system. Reports shall be certified as complete.
- E. Provide instructions and demonstration to the Owner’s representative for all equipment and systems installed under Division 23. Instruction and demonstration shall be appropriate for the size and complexity of the installed system.

- F. Include information for all products specified in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe 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.
 - 3. Use welders fully qualified and licensed by the state authorities.
- C. The specifications for certain products and alternative materials may appear in more than one section of Division 23. Work of Division 23 shall be coordinated for all sections of Division 23 to assure that where two or more items of any given product are furnished under Division 23 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 23.
- D. Except for spacing of hangers, provide hangers and supports in accordance with the latest issue of Manufacturer's Standardization Society (MSS) Specifications SP 58 and 69.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle all material and equipment in accordance with manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.
- B. 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.
- C. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

- A. The Mechanical systems are indicated on the Mechanical Drawings. Certain pertinent information and details involving the installation of Mechanical work appear on Architectural, Structural, Plumbing and Electrical Drawings. Become familiar with all Drawings and incorporate all pertinent requirements.
- B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the Mechanical work. Do not scale the Drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.

- C. Arrange for pipe spaces, chases, slots, duct shafts and openings in building structure during progress of construction, to allow for HVAC installations.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Coordinate installation of identification labels with locations of access panels and doors.
- F. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.
- G. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.
- H. Install identification devices prior to installation of ceilings and similar concealment.

1.10 ENERGY PERFORMANCE CRITERIA

- A. All equipment provided under Division 23 shall meet the requirements of the International, or State, Energy Code, ASHRAE Standard 90 or the latest issue of the Standards for Equipment in the National Energy Policy Act (NEPA), whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. In other Part 2 articles of various sections of Division 23 where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 2. Unless otherwise noted, substitutions of specified manufacturers shall comply with the requirements of Division 01.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder- joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full- face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 ESCUTCHEONS

- A. General: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter to closely fit around pipe, tube, and insulation of insulated piping and an outside diameter that completely covers opening.
- B. One piece construction on exposed piping in finished areas. Elsewhere, split pattern with setscrew. Provide deep pattern type where required to conceal protruding fittings and sleeve.
- C. Provide brushed brass escutcheons, except provide polished chromium plated escutcheons on pipes passing through walls, floors or ceilings wherever such pipes are exposed to view.

2.7 HANGERS AND SUPPORTS

- A. Acceptable Manufacturers
 - 1. Other Than Roof Supports
 - a. B-Line Systems, Inc.
 - b. Grinnell Company
 - c. National Pipe Hangers
 - d. Penn Construction Industries
 - e. Other approved United States manufacturer whose products comply with the referenced standards

B. Reference Standards

1. ASTM A36 - Specification for Structural Steel
2. ASTM A123 - Zinc (Hot-Dip Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip)
3. ASTM A653 G90 - Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process
4. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
5. AWS D1.1 - Structural Welding Code - Steel
6. MSS SP58 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Materials, Design and Manufacture
7. MSS SP69 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Selection and Application
8. NFPA 13 - Standard for the Installation of sprinkler Systems

C. Quality Assurance

1. Steel pipe hangers and supports shall have the manufacturer's name, part number and applicable size stamped in the part itself for identification.
2. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

D. General

1. Except for spacing of the hangers, design and fabrication of pipe hangers, supports and welding attachments shall conform to ANSI B31.9 or B31.1 as applicable.
2. Except for spacing of the hangers, hanger types and supports for bare and covered pipe shall conform to MSS SP69 for the temperature range except that only flat wide band hangers shall be used for hangers installed outside of insulation and plastic pipe.
3. Except for spacing of pipe hangers and elsewhere as otherwise indicated, horizontal and vertical piping attachment shall conform to the more stringent of this specification or MSS SP58 or MSS SP69. Continuous inserts and expansion bolts may be used.
4. All ferrous hangers, supports and hardware located outdoors shall be hot dip galvanized after fabrication per ASTM A123.
5. Hangers and clamps for support of bare copper piping shall be coated with copper colored (for identification) baked on epoxy paint. Use additional PVC coating of the epoxy painted hangers where necessary.
6. Provide suitable chromium plated brass supports for chromium plated pipe with exposed heads of bolts and screws chromium plated.
7. Hangers other than described above shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
8. Strut channels shall be pregalvanized in accordance with ASTM A653 G90 or shall have an electrodeposited finish.
9. All hangers and supports shall have some form of adjustment available after installation.

E. Pipe Hangers and Supports: Provide hangers as follows:

1. Hangers for Pipe Sizes to 1-1/2 Inch: Adjustable carbon steel ring or clevis.
2. Hangers for Hot or Cold Pipe Sizes 2 Inches to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Adjustable carbon steel clevis.
3. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke and cast iron roll.

4. Multiple or Trapeze Hangers: Factory-enameled steel channels with welded spacers and hanger rods or 12 gauge rolled formed ASTM A570 Grade 33 structural quality steel channels (strut), cast iron roll and stand for hot pipe sizes 6 inches and over. Cross section suitable for span and loading. Suspension by outside hanger rods sized for total load on trapeze.
 5. Vertical Support: Steel riser clamp.
 6. Floor Support for Hot Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Adjustable pipe saddle and pipe nipple attached to steel base stand, and concrete pier or steel support.
 7. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
 8. Design hangers to impede disengagement by the movement of supported pipe. Provide spring and neoprene hangers as required.
- F. Hanger Rod: Steel hanger rod zinc plated per ASTM B633.

2.8 THERMOMETERS

- A. Acceptable Manufacturers
1. Terice
 2. Taylor Instrument Company
 3. U.S. Gauge
 4. Weksler
 5. Weiss
- B. Dial Thermometer: Bi-metal type, case assembly of type 304 stainless steel, moisture proof heavy glass face, gasketed and hermetically sealed. Stem and fixed threaded connection of stainless steel, all welded construction. Provide 5-inch dial of heavy gauge aluminum with white matte finish, black graduation lines and numerals. Provide separable sockets of depth suitable for pipe size in which installed.
- C. Tube Thermometer: ASTM E1, liquid in place thermometer. Cast aluminum case, black baked epoxy enamel finish, 9-inch minimum liquid filled tube, brass stem, adjustable angle type with locking device and with brass union type separable socket. Socket length to suit installation. Mercury filled thermometer not allowed.
- D. Select range of thermometer to indicate normal operating temperatures at midpoint of scale. Scale division of 1 degree F for cold service and 2 degree F for hot service.
- E. Install wells with stem extending to center of pipe. Fill wells with oil or graphite and secure caps.

2.9 PRESSURE GAUGES

- A. Acceptable Manufacturers
1. Terice
 2. Taylor Instrument Company
 3. U.S. Gauge
 4. Weksler
 5. Weiss

- B. ASTM B40.1, Grade A phosphor bronze seamless Bourdon spring type with white face, black numerals, 4 ½-inch cast aluminum case, black baked epoxy enamel finish, brass bronze brushed movement and brass socket. Select range of gauge to indicate normal operating pressure of system at midpoint of scale.
- C. Provide ¼-inch brass coil siphon for steam gauge. For liquid gauge, provide brass snubber of material suitable for system fluid. Provide with needle valve.

2.10 IDENTIFICATION DEVICES AND LABELS

A. General

- 1. Products specified are manufacturer's standard products of categories and types required for each application as referenced in Part 3 of this section and elsewhere on the drawings or in Division 23 specifications. Where more than single type is specified for listed application, selection is Contractor's option, but provide single selection for each product category.
- 2. Products shall comply with requirements of ANSI A13.1 and OSHA where applicable.

B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ANSI 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. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
- 2. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ANSI A13.1, except as otherwise indicated.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers conforming to ANSI A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ANSI A13.1.

E. Pipes/Insulation Smaller than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe/insulation at each location.

F. Pipes/Insulation 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times the letter height and of length required for label.

G. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

H. Plastic Duct Markers: Manufacturer's standard laminated plastic, duct markers in the following color code:

- 1. Green: Cold air
- 2. Yellow: Hot air
- 3. Yellow/Green: Supply air
- 4. Blue: Exhaust, outside, return, and mixed air
- 5. For hazardous materials exhausts, use colors and designs recommended by ASME A13.1

6. Terminology: Include direction of air flow, duct service, system identification
- I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick. Width 1-1/2 inches wide on pipes with outside diameters (including insulation) less than 6 inches; 2-1/2 inches wide for larger pipes. Color shall comply with ANSI A13.1 unless otherwise indicated.
 - J. Valve Tags: Stamped or engraved brass with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide a hole for fastener. Brass wire-link chain, beaded chain, or S-hook fasteners.
 - K. Access Panel Markers: 1/16 inch thick engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed device. Provide center hole for attachment.
 - L. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on masonry walls for each page of valve schedule. Polished hardwood or extruded aluminum frame.
 - M. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening. 1/16 inch thick for units up to 20 square inches or 8 inch length, 1/8 inch thick for larger units. Self-tapping stainless steel screws or contact-type permanent adhesive.
 - N. Plasticized Tags: Preprinted accident-prevention tags, of plasticized card stock. Size approximately 3-1/4 by 5-5/8 inches. Brass grommets and wire fasteners.
 - O. Nomenclature: Large-size wording such as "DANGER," "CAUTION," or "DO NOT OPERATE", or as noted on the drawings in the specification.
 - P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
 - Q. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. General
 - 1. Furnish, deliver, erect, connect, and finish in every detail all materials, equipment and accessories required for the Work.
 - 2. Include in the work and in the bid minor details not usually shown or specified, but manifestly necessary for the proper installation and operation of the various systems, the same as if specified or shown.

3. If any departures from the Contract Documents are deemed necessary, submit details of such departure and the reasons therefore to the Architect for approval.
4. Be responsible to request clarification from the Architect on any conflicts represented between the drawings and specifications.
5. Adequately guard all exposed moving parts of equipment, such that contact by operating personnel will not cause personal damage or injury.

B. Layout and Coordination with Other Trades

1. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of all measurements in connection with the Work. Any change made in major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to use of equipment of a manufacturer other than that used as basis of design shall cause no interference with other Work.
2. Examine the Drawings of other trades, cooperate and coordinate with other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from the arrangements shown are required, consult with other trade involved. Come to agreement as to changed locations and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop drawings to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown on the drawings; provide such offsets or bends as required to meet structural or finish conditions.
4. Coordinate layout with architectural ceilings and lighting layouts and similar work.
5. Coordinate and be responsible for the required clearances in shafts, chases, furred partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review large scale composite Drawings showing space requirements that exceed those shown.
6. Install systems so that they do not interfere with any openings, doors or windows, or with other work, and so as to permit proper access.
7. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
8. Except where greater clearance is specified or required by applicable codes, rules or regulations, install piping, ductwork, fittings, valves, etc., to provide not less than 1 inch between their finished covering and the structure or adjacent work of any kind. The minimum space between finished hot piping of any kind and adjacent electrical conduit shall be 6 inches.
9. Make reasonable modifications in the layout to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the systems are to be installed in relation to the work of other trades. Issue such Drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades such that reasonable modifications cannot be made, detail and submit such deviation or conflict to the Architect for review.

11. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or as not to provide proper access for maintenance or repair, make necessary changes to correct the condition at no increase in the Contract sum.
12. For alterations to existing facilities, be fully responsible for coordinating work with all existing conditions. Verify location of existing piping, ductwork and equipment in the field. Relocate or offset new piping and ductwork, and make reasonable modifications to existing piping and ductwork, as required to fit in available space whether or not such relocation of offset is shown on the Drawings.

C. Manufacturer's Instructions and Recommendations

1. Perform the installation, cleaning, testing, calibration, and start up of all material and equipment in accordance with the manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of the specifications.
2. Should a conflict exist between specifications and manufacturer's instructions, consult with the Architect.

D. Electrical Rooms

1. Do not install any piping, ductwork or equipment in or through an electrical room or similar room containing electrical equipment, other than piping, ductwork or equipment exclusively serving the room or equipment in the room.
2. If there is a conflict between the above requirement and the Drawings, the above shall govern. If reasonable modifications cannot be made to accommodate this requirement, obtain instructions from the Architect before proceeding with the work.

E. Painting

1. Except where specified otherwise in Division 23, Work of Division 09 will provide painting of HVAC systems, equipment and components.
2. Protect all equipment from rust, corrosion, and similar damage by either factory applied or field applied protective coatings.
3. Repair marred and damaged factory painted finishes with manufacturer's touch up paint and application procedures to match original factory finish.

F. Wall and Ceiling Access Doors

1. Access Doors shown on Architectural Drawings will be provided under Division 08.
2. Furnish access doors required for access to concealed dampers, valves, air vents, traps, cleanouts, unions, expansion joints, and other equipment where no other means of access is available. Access doors shall be of adequate size for the service requirements, minimum clear opening of 14 inches by 16 inches.
3. Access doors shall be as specified in Division 08. Coordinate locations of access doors with all trades.

3.2 PENETRATIONS

A. General

1. Coordinate with other trades as to the size and location of openings to be provided in new floors, walls, roofs and ceilings as construction progresses.
2. Do not cut openings in new or existing floors and walls without proper structural reinforcement.
3. Install both piping and seals so as to maintain integrity of seals with expansion and contraction of piping.

B. Sleeves

1. Provide each pipe, duct or conduit passing through a masonry or concrete wall, floor or partition, and elsewhere as indicated, with a sleeve made from standard weight galvanized steel pipe for pipe or conduit and 12 gauge galvanized sheet steel for ducts, with smooth edges, securely and neatly set in place.
2. Select sleeves two pipe sizes larger than any pipe or conduit to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide minimum of 3/8 inch clearance.
3. Be responsible for the proper location and alignment of all sleeves.
4. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
5. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral water stop flanges, where they are to receive either water tight or hydrostatic seals.

C. Fire Rated Penetrations

1. Provide through-penetration fire-stop sealing system for pipe, duct and conduit penetrations through fire or smoke rated construction. Refer to Division 07 for through- penetration fire stop sealing system.
2. Coordinate with Division 07 to determine requirements for sleeves and clearances.
3. Select duct sleeve sizes to suit requirements of manufacturer of fire and/or smoke dampers.

D. Interior Non-Rated Wall Pipe Penetrations

1. For acoustically treated partitions, and walls between mechanical equipment rooms and occupied spaces, fill annular void at penetration with acoustical sealant.

3.3 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Make all necessary alterations to existing Division 23 systems as required for removing or for connecting or extending these systems to new work and for revisions in existing work as indicated and as required, whether indicated or not. Match new materials in altered systems with existing materials unless otherwise indicated.

C. Continuity of Existing Services

1. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for shutdown activities, coordinate with Architect, Owner and other trades, and obtain written approval from Owner prior to

proceeding with the work. Include work scheduled for off hours, when Owner requires that shutdown and interruption of facilities occur during unoccupied times.

2. Prepare and set notices on services and equipment that are temporarily shut off or disconnected.
- D. Provide shutoff valves to isolate new work from existing and temporary or permanent connections to new work as required for proper testing and cleaning of new work.
- E. All relocations of existing work shall be accomplished using new materials and accessories unless specifically noted otherwise.
- F. Where equipment, ductwork and piping is removed or disconnected under Division 23, perform the work in such a manner that no damage is done to the structure or remaining portions of the existing systems. Do not under any circumstance place stress on existing pipe and fittings that are to be reused. Be fully responsible for and repair, at no additional expense to the Owner, any leaks developing in existing piping due to failure to take proper precautions when making alterations.
- G. Disconnect, demolish, and remove HVAC 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: Do not abandon any piping in place unless specifically noted to do so. Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Do not abandon any ductwork in place unless specifically noted to do so. Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 8. All materials and equipment removed or disconnected by Division 23, which is not to be reused or delivered to Owner, shall be removed from the premises. Provide owner first right of refusal of equipment prior to removal from site.
- H. 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.
- I. Remove all piping, ductwork and equipment hangers and supports.
- J. Cap tight unused connection at mains and risers behind finished surfaces.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 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 Coordination Drawings.
- C. Install all piping in accordance with best practices of trade and latest code requirements. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Use uniform system materials throughout building.
- D. Install components having pressure rating equal to or greater than system operating pressure.
- E. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum head room. Cut piping accurately to measurements established at building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible without sags between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.
- F. Pitch all systems for proper venting at high points and to drain at low points where the systems can be completely emptied. Install vents at all high points and drains at all low points, including where offsets and bends in horizontal pipe runs create a low point. Provide drain points with bronze hose end drain valves.
- G. Do not install piping above or through electrical rooms, telecommunication rooms, or similar room having a large collection of electrical equipment.
- H. Keep pipe and fittings clean from cutting burrs, foreign matter and defects in structure and threading. Make all cuts square. Ream after cutting. Bevel plain ends of steel pipe. Clean off scale and dirt inside and outside before assembly. Remove welding slag or other foreign matter inside and outside.
- I. Install piping within building concealed in walls, furred spaces, pipe spaces or above suspended ceilings. Do not build in or bury horizontal piping within partitions. Install exposed piping as closely as possible to walls, ceilings and columns, allowing space for installation of insulation and access for valve operation.
- J. Install piping sections using greatest length possible in all cases. The use of short lengths socketed together will not be allowed.
- K. The use of lampwick or other material for packing threads, caulking or wrapping of joints to stop or prevent leaks or correct faults is not permitted. The use of long screws having right and left hand threads or couplings is not permitted.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- M. Install piping to permit valve servicing and application of insulation.
- N. Provide offsets and loops as required for piping crossing a building expansion joint to accommodate building movement, whether or not shown on the drawings.
- O. Changes in Pipe Size and Direction

1. Make reduction or increase in pipe size with fittings. Use eccentric reducing fittings in horizontal piping. Use reducing tees in pressure piping for side outlet reduction only, not on run. Bushed fittings, notched or straight runs to form tees, or any similar fabrication method will not be permitted.
2. Make changes in direction with standard fittings. Mitering of pipe to form elbows or similar fabrication method will not be allowed. Bending of piping will not be permitted.

P. Electrolysis Control

1. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
2. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric union to prevent electrolytic action between the ferrous and nonferrous metals. At branch connections off mains, provide shut off valve upstream of dielectric union in order to isolate downstream union.
3. Where copper or brass piping, tubing or fittings are anchored to, supported by, or come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, plastic or equivalent material to assure prevention of electrolysis.

Q. Equipment Piping

1. Verify final locations of equipment for rough in of piping connections.
2. Provide shut off valves in the supply and return to each item of equipment. Suitably locate equipment isolation valves to facilitate removal of equipment.
3. Provide piping from pump glands, cooling coil drain pans, relief valves or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge, terminating with plain end cut at a 45 degree angle.

R. Expansion and Contraction of Piping

1. The piping installation shall be free of stress. Run all piping with full allowance for expansion or contraction. Base expansion calculations on 50 degree F installation temperature to 200 degree F for hot water systems and temperature of steam pressure for steam systems, plus 30% safety factor.
2. Evaluate the complete piping layout and notify Architect of additional anchors or expansion joints and any deviations required to compensate for expansion.
3. Make connections to equipment in such a manner as to eliminate undue strains in piping and equipment. Install sufficient number of elbow swings to allow for proper expansion and contraction of piping at the point of connection to mains and equipment.
4. Fabricate expansion loops with long radius welded fittings in steel piping and with long radius copper sweat fittings in copper piping.
5. Provide adequate pipe guides on each end of the expansion device to preserve alignment and pitch.
6. Install pipe hangers and supports in such a manner as to not cause an anchor condition in any direction.

S. Pipe Anchors

1. Install anchors where required to direct pipe expansion properly into expansion joints, loops or offsets and to prevent transfer of loading and stresses to connected equipment.

2. Pipe anchors may consist of heavy steel clamps bolted or welded to piping and provided with lugs and bolts for clamping and attaching anchor braces. Design anchors to restrict pipe movement and fasten to main members of building structure in most effective manner to secure desired results.
3. Do not attach supports, anchors or stays in places or in such a manner that will damage construction or integrity of the structure, either during installation, by weight of the pipe, or by expansion and contraction of the pipe.

T. Pipe Insulation Inserts and Shields

1. Refer to Section of Division 23, "HVAC Insulation" to coordinate specific insulation thicknesses and requirements. At hanger locations for insulated piping 1 ½ inches and larger where hanger support is outside the insulation, provide inserts of exploded silica pipe insulation between pipe and hanger. Density and compression strength suitable for pipe size and support spacing as required by MSS SP-58, Paragraph 9 and MSS SP-69, Table 3. Provide inserts as required for smaller piping to prevent deformation of insulation. Inserts of equal thickness to adjoining insulation, provided with vapor retardant seals, and of proper length to fully support pipe at each hanger location. Manufactured by Value Engineered Products Max Span; or equivalent.
2. At all hanger locations for insulated piping where hanger is outside of insulation, provide galvanized sheet steel shield formed to fit insert/insulation, extending up to pipe centerline. Length 12 inch minimum when insert is not required. Where inserts are provided, length of shield 4 inches less than insert length. Provide shields 16 gauge for piping up to 4 inches, 12 gauge for piping 6 inches and larger. Shields shall have preformed ridges on each side of hanger to prevent hanger from slipping along shield.
3. Preformed insulated pipe saddles may be used in lieu of insert and shield where appropriate. Thickness of insert or pipe saddle same thickness as pipe insulation.

3.5 WELDING, SOLDERING AND BRAZING

- A. Do not employ workers who have not been fully qualified and certified for the specified procedures.
- B. Pipe Welding, Black or Galvanized Steel Pipe: Perform all welding of black or galvanized steel pipe by shielded metallic arc method of fusion welding, in accordance with welding procedures of AWS (American Welding Society) D10.12 recommended procedures for welding low carbon steel pipe, or other approved procedure, conforming to requirements of ASME/ANSI B31.1 for high pressure steam boiler piping and B31.9 elsewhere.
- C. Pipe Welding Stainless Steel Pipe: Refer to other Sections of Division 23 for welding requirements.
- D. Structural Steel Field Welding: Comply with AWS D1.1 procedures for manual shielded metal- arc welding, appearance and quality of welds, methods used in correcting welding work, and 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. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

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- E. Soldering: Comply with the requirements of the AWS Soldering Manual.
- F. Brazing: Comply with the requirements of the AWS Brazing Manual and AWS A5.8 specification for filler materials for brazing.

3.6 UNIONS

- A. In Screwed Steel Pipe, 2 inches and smaller: Screwed, Class 250 malleable iron, brass to iron seat, ground joint union with brass seat ring pressed into head piece. Provide galvanized unions in galvanized pipe.
- B. In Welded Steel Pipe, 2 inches and smaller: Class 3000 carbon steel socket welded union, steel to steel seat and ground joint. Provide stainless steel in stainless steel piping.
- C. In Copper tubing, 2 inches and smaller: Class 200 wrought copper, solder type, brass ground joint union.
- D. In Brass Piping, 2 inches and smaller: Class 250 cast bronze, screwed ends, brass ground joint unions. Provide chromium plated unions in chromium plated piping.
- E. Provide companion flanges in piping 2 ½ inches and larger.

3.7 PIPING CONNECTIONS

- A. Refer to other Sections of Division 23 for additional requirements.
- B. Flanged Connections: Make with nonasbestos gaskets of 1/8 inch thick best quality material as recommended by manufacturer for the service application. For steam piping, factory manufactured for flange/connection size/type as manufactured by Flexitallic. For other piping services either Flexitallic or gaskets factory cut for flange size as manufactured by Garlock Packing Division, Colt Industries, or equal. Align flange surfaces parallel. Install gasket concentrically positioned. 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 using torque wrench.
- C. Mechanical Couplings: Prepare pipe and install in accordance with manufacturer's instructions. Standard wall steel pipe either roll or cut grooved at Contractor's option, all sizes, except provide cut grooved as required to accommodate thermal expansion and contraction. Heavy wall steel pipe cut grooved all sizes. Light wall steel pipe roll grooved all sizes. Copper tubing roll grooved.
- D. Soldered Joints: Unless noted otherwise, make with appropriate flux and solder. Clean tubing ends and fittings before assembly. For piping 2 inch and larger tin tubing and fittings before assembly. For tubing 2-1/2 inch and larger use circular flame torch for soldering. The use of lead flux or solder and finishing with 50-50 solder is prohibited.
- E. Threaded Pipe: Make full, clean-cut standard ANSI/ASME B1.20.1 taper pipe threads using sharp dies. Carefully cut, ream or file out to size or bore, removing all chips. Use Schedule 80 pipe for all screwed close and shoulder nipples. Do not use all thread nipples. Provide teflon tape or other approved nontoxic joint compound, applied to male thread only.

- F. Welding Connections: Use only factory made welding fittings, same weight as piping, on welded pipe, except that Bonney Forge WELDOLET or THREADOLET, or Allied Type 1 Branchlet fittings, of same weight as connecting piping, may be used for branch takeoffs two or more commercial pipe sizes smaller than main. All elbows long radius.
- G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D2855.
- H. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
- J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.9 PROTECTION OF WORK

- A. Clean pipe, tubing, fittings, valves, piping specialties, ductwork and equipment before installation and keep clean while the work is in progress.
- B. Securely close open ends of pipe and tubing and openings in other material and equipment until installed, during installation, and until finally connected or otherwise finished, with caps, plugs or other approved closure devices designed for such service.
- C. Protect factory finished equipment, fixtures and devices with approved temporary covering material where those items are installed so as to be subject to accidental damage or abuse. Contractor shall remove all temporary covering material at the conclusion of the work or as directed.

- D. Protect the work of other trades and property of Owner from damage and assume full responsibility for the cost of repairing or replacing any damage to such work or property caused by the performance of the work under Division 23.

3.10 CLEANING OF SYSTEMS

- A. Refer to Division 23 “HVAC Water Treatment” for additional cleaning and system flushing requirements.
- B. Following completion of system testing, thoroughly clean all piping systems by flushing with water or other approved method, or as otherwise specified. Completely remove all dirt, scale, oil, grease and other foreign substances that may have accumulated in systems during installation.
- C. Carefully wipe out, wire brush, or if necessary, sand blast sections of pipe lines between temporary or permanent strainers and equipment they are to protect. Replace all permanent strainer screens with temporary screens during cleaning process. Remove temporary screens and reinstall permanent screens after cleaning is completed.
- D. Disconnect automatic devices that can become clogged during cleaning process and do not connect permanently until cleaning process is complete.
- E. Clean all ductwork, piping and equipment of dirt, scale, plaster, concrete, splattered paint and other foreign matter.
- F. Clean all grease and cuttings from stainless steel piping and trim.
- G. Clean all strainers, dirt pockets, drip legs, traps and other accessories that may collect foreign matter.

3.11 GROUTING

- A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, 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.
- B. Packaging: Premixed and factory packaged. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- C. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout.
- D. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout according to manufacturer’s written instructions.

3.12 HANGERS AND SUPPORTS

A. General

1. Support major piping 3 inch and above, ductwork, tanks and other equipment to the structure above (beams and girders) or by means of struts or brackets to columns. Do not support from floor or roof decks. Do not overload structural members to which supports are attached. Hanger spacing not to exceed MSS SP69.
 - a. Provide hangers, rollers, threaded rods, turnbuckles, deflection guides, deflection provisions, inserts, beam clamps and all miscellaneous specialties for attachment of hangers and supports to structure.
 - b. Provide all rods, angles, rails, struts, brace plates, structural steel, platforms and other items required for suspension or support of piping, ductwork, tanks and equipment.
 - c. Provide supplemental angles, channels, plates or other reinforcement where supports are required between building structural members. Size supports for weight of duct, pipe, pipe contents, equipment fittings and other items, plus a 200 pound live load. Attach supplemental supports in a manner that will not weaken or overload structural members. Weld steel according to AWS D-1.1.
 - d. Attach by welding, clamping, concrete inserts, drilled in mechanical type anchors (Hilti or equal) and other approved means. Adhesive type anchors are not approved.
 - e. Place grout under supports for equipment, and make a smooth bearing surface.
 - f. For seismic restraint, provide double-sided beam clamp loaded perpendicularly to beam for seismic anchor point.
2. No lead shield anchors, powder or power fasteners permitted for attachments.
3. Do not use perforated strap hangers. Do not use steel strap hangers on piping.
4. Wherever possible, support shall be provided directly to main steel or concrete framing beams. If spacing of structure exceeds spacing required to support the mechanical work, supplemental channel or unistrut framing shall be designed and provided by the Contractor.
5. Support all mechanical work independently of other trades. Under no circumstances shall work be supported or suspended from ceiling grids, piping or other supports by other trades.
6. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.

B. Pipe Hangers and Supports

1. Unless otherwise required to avoid overloading of structural members or for seismic restraint, support horizontal steel and copper piping as follows:

Nominal Pipe Size (inch)	(a)Maximum Distance Between Support (feet)		Hanger Rod Diameter (inch)
	Steel Pipe	Copper Tubing	
up to 3/4	6	5	3/8
1 to 2	6	6	3/8
2-1/2 to 3-1/2	10	8	1/2
Trapeze Hanger Rod			(b)

- a. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
 - b. As required to carry weight of trapeze channel, span of piping with contents, insulation and supports, plus a 200 pound live load.
 - c. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
2. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers and expansion joints/loops.
 3. Place a hanger within one foot of each horizontal elbow.
 4. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
 5. Vertical Piping Support:
 - a. Unless otherwise required to avoid overloading, of structural members or for seismic restraint, support vertical piping with clamps spaced appropriately as to type and weight of piping, minimum spacing at every other floor and below roof. Support vertical soil pipe at each floor at hub. For exposed piping in stairs and finished areas, locate clamps below floor and secure to structure below floor as required.
 - b. Support vertical steel pipe at a maximum of 15 feet spacing.
 - c. Support vertical copper pipe and tubing at a maximum of 10 feet spacing.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Space hangers for smallest pipe size or provide intermediate supports for smaller pipe as specified above for individual pipes.
 7. Where practical, support riser piping independently of connected horizontal piping.
 8. Support pipe runs in a manner to minimize stress in the pipe or tubing and on bodies of valves and fittings.
 9. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 10. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
 11. For piping subject to sweating (e.g.: domestic cold water, chilled water, refrigerant suction, drain piping for air conditioning equipment, heat recovery piping, etc.) and for insulated piping requiring roller supports, install hangers outside insulation and provide pipe insulation protection shields as specified in this section. For all other piping, hanger may be attached to the piping before insulation is applied or may be installed outside the insulation with insulation protection shields.
 12. Do not support nonferrous piping with ferrous materials even on a temporary basis.
 13. Do not support piping or ductwork from other piping or ductwork.
 14. Install hanger rods subjected to tension only. Accomplish lateral and axial movements by proper linkage in rod assembly. Secure hanger to hanger rod with two bottom lock nuts.
- C. Duct Hanger and Supports: Refer to Section 23 30 00 "Ductwork and Ductwork Accessories".

3.13 IDENTIFICATION

- A. Identify all new and altered equipment, new and altered exposed and concealed ducts and new and altered exposed and concealed pipe with legible lettering, applied after finish painting, in a color to contrast with basic color in accordance with ANSI A13.1 and OSHA.
- B. Identify piping by name of pipe content and direction of flow near major equipment items, adjacent to valves or flanges, adjacent to gauges or thermometers, at each tee, at changes in direction, on each side of a penetration of a wall or floor, at each access door or panel and then at maximum 20 foot centers in congested areas and 50 foot intervals elsewhere; indicate flow direction with arrows. Identification shall be by means of plastic markers or tape or painted on the finished pipe surface by using stencils. Lettering shall not be smaller than one third of the pipe diameter and directional arrows not less than 1/2 inch wide and 12 inches long.
- C. Identify equipment and operating devices such as switches, starters and similar equipment, by the equipment numbers shown on Drawings or by the Owner's numbering system, if so directed.
 - 1. Include the type of service or the name of areas served.
 - 2. Lettering minimum 1 inch high.
 - 3. Nameplates shall be two tone plastic, or printed white paper enclosed in a transparent, laminated plastic case with permanently sealed edges.
 - 4. Attach securely to equipment, or where this is not practicable attach by brass link chains.
 - 5. Do not stencil surfaces exposed in public areas.
- D. Furnish for each valve, except those immediately adjacent to apparatus, a 2-inch diameter nonferrous metal tag with figures stamped on the tag.
 - 1. Number tags for HVAC H-1, H-2, etc.; Use Owner's numbering system if so directed.
 - 2. Fasten tags to valves with nonferrous S hooks and nonferrous chains.
 - 3. Where valves are located above removable acoustical tile ceilings, identify the tile section below the valves by an approved color pin system.
 - 4. Furnish duplicate framed schedules showing the location of each valve, system or equipment it serves, manufacturer, and figure number.
- E. Identify exposed ductwork similar to piping.
- F. Identify access doors to fire dampers with access panel markers or by stencils with the words "Fire Damper Access" except for dynamic fire dampers, use the words "CAUTION Dynamic Fire Damper Access". Provide approved markers to locate fire dampers concealed above ceilings.

3.14 TESTING OF PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Refer to individual piping system specifications elsewhere in Division 23 for additional piping system testing requirements.
- B. Provide materials and equipment required for testing. Test and make tight all new piping systems and alterations and connections to existing piping system.
- C. Take precautions during testing to insure safety of personnel and equipment. Provide systems to be pressurized with appropriate gauges and blowouts or relief valve set at a pressure no more than one

third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Make good at no increase in Contract sum damage to work or work of other trades caused by failure to observe proper precautions.

- D. Test piping systems prior to application of insulation. Testing as stipulated herein shall be considered minimum, and where tests stipulated by lawful jurisdictional authorities exceed these requirements, such more stringent tests shall be performed. Tests shall be witnessed and approved by the authorities having jurisdiction over the work.
- E. Concealed work shall remain uncovered until required tests have been completed. Provide proper sectionalizing devices so that portions of a system may be tested as appropriate.
- F. Isolate and exclude from tests all in line equipment, instruments, gauge glasses, flow meters and all other devices not capable of withstanding test pressure.
- G. Use ambient temperature water as testing medium, except where otherwise specified and except where there is a risk of damage due to freezing.
- H. Apply soap solution to all joints of pneumatically tested systems while system is being subjected to test pressure.
- I. Maintain test pressures sufficient length of time to permit thorough inspection of all joints. Where leaks are observed, replace defective work or material. Caulking of screw joints or holes is not acceptable. Repeat entire test as many times as necessary, until successful completion of test with no leaks.
- J. Prepare written report of testing.

3.15 BALANCING, ADJUSTING AND PERFORMANCE TESTING

- A. Testing, adjusting and balancing of air and water systems will be provided under Division 01 "Testing, Adjusting and Balancing of HVAC Systems".
- B. Installing Contractor(s) responsible for the work specified in Division 23 shall perform all work necessary to place systems in full operation prior to start of testing, adjusting and balancing work. In addition, Installing Contractor shall perform certain additional preparatory work required for testing, adjusting and balancing as specified in various Sections of Division 23.
- C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.
- D. Cooperate with testing, adjusting and balancing Contractor in coordination and scheduling of testing, balancing and adjusting work. Furnish approved manufacturer's technical data and shop drawings for equipment, including fan and pump performance curves.

3.16 INSTRUCTION AND DEMONSTRATION

- A. Upon completion of all work and all tests, and at a time mutually agreed on by Contractor, Architect and Owner, Installing Contractor shall operate systems in all parts and at their expense for sufficient length of time to demonstrate the mode of operation and definitively determine whether the systems as a whole are in first class working condition. Immediately correct, at no cost to Owner, any defects that may develop during this period of operation and place systems in first class working condition before being finally turned over to Owner.
- B. Provide experienced operating personnel to instruct Owner's authorized employees in the operation, adjustment and maintenance of systems and equipment installed under this Contract. Provide instructions for the period of time appropriate for the size and complexity of the system, or as requested by Owner.

3.17 MANUFACTURER'S SUPERVISIONS AND STARTUP SERVICE

- A. Include manufacturer's supervision/startup/certification and special instruction service for equipment as specified in various Sections of Division 23. Be responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified work. Make any corrections/modifications to the installation as required by the manufacturer at no additional cost to Owner.
- B. The manufacturer's engineer or authorized service personnel shall check the equipment for its conformance to the Specifications, for proper installation and run the system in all modes of operation to ascertain that the unit will function properly. Make necessary adjustments to insure optimum efficiency and trouble free service.
- C. After completion of the startup procedures, the manufacturer shall certify, in writing, that the equipment is installed in accordance with their requirements and is operating in accordance with the intent of the Specifications.

3.18 COMMISSIONING

- A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".
- B. Ensure participation of major equipment manufacturers or their representatives.
- C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.
- D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at

their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 23 05 00

SECTION 23 05 13 – ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

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 extent of electrical equipment and electrical wiring that is responsibility of Division 23.
- B. Section includes general requirements for motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- C. Related Sections:
 - 1. Variable Frequency Motor Speed Controllers furnished by Division 23 are specified in Division 26.

1.3 REFERENCE STANDARDS

- A. ANSI/IEEE 112 (C50.20): Test Procedure for Single Phase Induction Motors.
- B. ANSI/IEEE 114 (C50.21): Test Procedure for Polyphase Induction Motors and Generators.
- C. NFPA 70: National Electric Code (NEC)
- D. UL: Underwriters Laboratories

1.4 SUBMITTALS

- A. Product Data: Include with equipment submittals, data pertinent to electrical characteristics; motor size, type, power requirements, wiring requirements.

1.5 QUALITY ASSURANCE

- A. Provide electrical products, including those factory mounted or factory furnished, which have been tested, listed and labeled with Underwriters' Laboratory (UL) or Electrical Testing Laboratory (ETL).
- B. There shall be no field modifications made to any materials, equipment and systems that would violate the listing and labeling.

- C. Comply with Division 26, NEC and NEMA as applicable to wiring methods, materials and equipment and equipment, construction and installation.

1.6 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. Duct Smoke Detectors: Duct mounted smoke detectors will be furnished by Division 28 and installed by Division 23. Detectors will be wired to Fire Alarm system by Division 28.
- C. Smoke Dampers: Smoke dampers will be provided by Division 23. Smoke damper will be wired to the Fire Alarm system by Division 28. Wiring and addressable interface module will be provided by Division 28.
- D. Air Volume Control Boxes: Air volume control boxes with integral 120/24 volt transformer will be provided by Division 23. Control wiring to and from air volume control boxes will be provided by Division 25.
- E. Wiring Under Division 26 “Electrical”
 - 1. Power wiring under Division 26 will include power feeders from source of building power to wiring terminals on the equipment, unit mounted disconnects, or control panels.
 - 2. Where disconnect switches for equipment are provided by Division 26, power wiring under Division 26 will include wiring from disconnect to wiring terminals on the equipment.
- F. Wiring Under Division 25 “Instrumentation and Control For HVAC”
 - 1. Wiring under Division 25 shall include all connections to control devices, wiring of pressure and flow control switches, flow meters and similar mechanical-electrical devices for mechanical systems to control panels, interlock wiring, control relays, and minor power wiring to auxiliary components for major pieces of apparatus such as damper motors, solenoid valves and control valve motors.
- G. Provide all other power and control wiring for Division 23 systems and equipment in accordance with the requirements of Division 26, required for complete operation, including wiring that is specified for factory prewired equipment, but not so provided.
- H. Short Circuit Current Ratings (SCCR) for HVAC Equipment
 - 1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered mechanical equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be

equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the HVAC equipment shall be equal to or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

HVAC equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment, and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.

All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned 'Resubmit' or 'Rejected'.

No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

I. Electrical Ratings

1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be submitted for approval and be completed by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 ELECTRICAL WIRING

- A. Electrical wiring provided by Division 23 shall be in accordance with the requirements of Division 26.

2.2 MOTORS

- A. Acceptable Manufacturers:
 1. Toshiba
 2. General Electric

3. Lincoln
4. Reliance
5. U.S. Electric
6. Marathon
7. Baldor

B. General Motor Requirements

1. Construct in accordance with the latest NEMA MG 1 standards and UL 1004, test in accordance with NEMA MG 1, ANSI/IEEE 112 and ANSI/IEEE 114. Except where more stringent requirements are indicated, comply with the following.
2. Single phase/3 phase (polyphase) and voltage characteristics as scheduled on drawings, 60 Hz.
3. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors that will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
4. Class B insulation unless otherwise specified.
5. Provide each motor with a conduit terminal box or factory installed cord set with molded plug as applicable.
6. Provide motors with grease or lubrication fittings. For specific applications, and at the approval of the Architect, the use of permanently lubricated or lifetime bearings will be permitted.
7. Open dripproof (ODP) or totally enclosed fan cooled (TEFC) type with a minimum service factor of 1.15 unless otherwise specified herein or in other section of the specifications.

C. Motor Characteristics

1. Duty: Continuous duty at 100 percent of rated capacity at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
2. Capacity and Torque Characteristics: Sufficient 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 considering service factor.

D. Polyphase Motors

1. Squirrel cage induction type conforming to the following requirements unless noted otherwise:
2. Description: NEMA MG 1, Design B, medium induction motor, unless otherwise required by starting torque.
3. Separate winding for each speed for multispeed motors.
4. Efficiency:
 - a. Single speed motors larger than 100 Hp shall be of "Energy efficient" design as defined in NEMA MG-1.
 - b. Single speed motors 75 Hp shall be of "Premium efficiency" design, as defined in NEMA MG-1. Class F insulation.
 - c. Motors driven by variable frequency motor speed controller (VFD) shall be "Premium" efficiency, as defined in NEMA MG-1. NEMA Design B, Class H insulation.
5. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. For motors 1.0 Hp and smaller, prelubricated, antifriction sleeve bearings.

6. Motors drawing 1000 watts or more at full load shall have a power factor rating of at least 85% without external capacitor correction. Verify efficiency in accordance with NEMA MG-1. Test per NEMA MG-1, ANSI/IEEE 112. Display efficiency on nameplate in accordance with NEMA MG-1.
7. Special Requirements:
 - a. Motors installed in air handling unit directly downstream of cooling coils or humidifiers shall be totally enclosed fan cooled (TEFC) type.
 - b. Motors driven by variable frequency motor speed controller (VFD) shall be inverter duty rated, thermally protected, in full compliance with NEMA MG-1 Part 31.
 - c. For motors driven by VFD, provide motor shaft grounding ring (SGR) to protect against electrical discharge machining (EDM) motor bearing damage.
 - d. Provide next size larger motor and drive, where fan motor brake horsepower, including all drive and belt losses, exceeds the following limits:
 - 1) 85% of nameplate horsepower for motor 40 Hp and smaller in size.
 - 2) 90% of nameplate horsepower for motor 50 Hp through 100 Hp in size.
 - 3) 95% of nameplate horsepower for motor larger than 100 Hp.

E. Single Phase Motors

1. Motors larger than 1/20 hp shall be energy efficient capacitor start type to suit starting torque and requirements of specific motor application:
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

- A. Variable frequency motor speed controllers (VFD), including line reactor and/or harmonic filter as required, shall be furnished by Division 23 in accordance with Division 26 Section "Variable Frequency Motor Speed Controller (VFD)".
- B. It shall be the responsibility of Division 23 Sections to properly match the motor and drive.
- C. All variable frequency motor speed controllers furnished by Division 23 shall be of the same manufacturer.

2.4 MOTOR STARTERS

- A. Motor starters for chillers and certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 23. All other motor starters, except variable frequency drives, shall be provided by Division 26.

2.5 POWER FACTOR CORRECTION

- A. Power factor correction for certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 23.
- B. For each motor 25 hp and larger, except those driven by a VFD, furnish 3 phase, 60 hertz, biodegradable, low toxicity type capacitor for power factor correction with maximum rating allowed by motor manufacturer sufficient to raise overall motor power factor to 95%.
- C. Provide NEMA enclosure with gray enamel finish, porcelain bushings, non-PCB impregnated dielectric resistors, current limiting fuses, mounting brackets, internal connections and appurtenances, including blown fuse external indicator.
- D. Factory test capacitors for compliance with referenced NEMA and ANSI/IEEE Specifications. Submit certified test reports with equipment shop drawings.

2.6 CONTROL PANELS

- A. Include in control panels provided as a part of apparatus specified in Division 23, fused disconnect, circuit breaker or motor circuit protector combination starter with overload protection for each motor, contactors, and electric heaters, if required. Provide 120 volt control circuit and other required circuit protection. Where remote controls are required, they shall operate at 120 volt maximum, with properly fused control transformer provided for that purpose.

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

- A. Power wiring will be provided under Division 26 and control wiring will be provided under Division 23. Provide power and control wiring for Division 23 systems and equipment for interconnecting wiring on apparatus that has not been factory installed.

3.2 MOTORS

- A. Provide electric motors required for equipment specified in the various sections of Division 23, designed and wound for electrical characteristics shown on the Drawings.
- B. Select motors for quiet operation and for sufficient capacity to operate driven devices under all conditions of operation without overloading.
- C. Install motors in accordance with manufacturer's published instructions. Mount direct drive connected motors securely in accurate alignment. For belt drive motors, use adjustable mounting bases, align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

D. Extend lubrication lines to accessible locations.

E. Startup

1. Check operating motors, both factory and field installed, for unusual conditions during normal operation. Coordinate with the balancing and commissioning of the equipment for which the motor is a part.
2. Report unusual conditions and correct deficiencies.

3.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

- A. Deliver variable frequency motor speed controllers not factory mounted on equipment to Division 26 for field installation and wiring.

3.4 MOTOR STARTERS

- A. Deliver motor starting equipment not factory mounted on equipment to Division 26 for field installation and wiring.

3.5 POWER FACTOR CORRECTION

- A. Deliver capacitors not factory mounted on equipment to Division 26 for field installation and wiring.

END OF SECTION 23 05 13

SECTION 23 05 40 - VIBRATION ISOLATION FOR HVAC SYSTEMS

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. Vibration isolation devices, accessories, materials and related items for new equipment, piping and ductwork as may be required to prevent the transmission of vibration to the building structure.
 - 2. Wind restraint devices, accessories, materials and related items for new equipment, piping and ductwork as may be required to keep all components in place during a wind event and operational where this specification so requires.

1.3 REFERENCES

- A. ASCE: American Society of Civil Engineers, ASCE 7, latest edition.
- B. ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., Applications Handbook, latest edition.
- C. ASTM: American Society for Testing and Materials.
- D. AWS: American Welding Society.
- E. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association, Duct Construction Standards – Metal and Flexible, latest version.
- F. MSS: Manufacturer's Standardization Society.
- G. IBC: International Building Code.

1.4 SUBMITTALS

- A. Product Data: Annotate to indicate application of each product submitted and compliance with the specifications.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

- B. Product Schedule or List: Provide schedule of all vibration isolated equipment and all vibration isolated piping and ductwork systems. Include the following for each piece of equipment and, as applicable, for each piping and ductwork system:
1. Identification. Include equipment ID where applicable
 2. Isolator type(s) with identification reference numbers of applicable product data and shop drawings.
 3. Actual load for each isolator type.
 4. Actual static deflection expected under actual load for each isolator type.
 5. Specified minimum static deflection under actual load for each isolator type.
- C. Shop Drawings:
1. Fabrication details of roof curbs, steel rails, steel base frames and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method and location of equipment bolts.
 2. Drawings showing methods of suspension, support guides for piping and ductwork.
 3. Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
 4. Details and sizing of housekeeping pad(s) showing reinforcement, method of attachment to structure and method of attachment of equipment restraint(s).
 5. All other special details necessary to convey complete understanding of work to be performed.
 6. Provide the number, size and location of braces and anchors for suspended piping and ductwork on shop drawings.

1.5 QUALITY ASSURANCE

- A. It is the objective of this specification to provide the installation of vibration isolation equipment and devices for the avoidance of excessive noise and vibration in the building(s) due to the operation of machinery or equipment and/or due to interconnected piping, ductwork or conduit.
- B. All vibration isolation equipment and devices, including auxiliary steel bases and pouring forms, shall be the products of a single manufacturer, hereinafter called the isolation manufacturer, unless otherwise allowed in writing by the Architect, shall be certified by the isolation manufacturer and shall be furnished by the isolation manufacturer or his authorized representative, who shall be responsible for performing all work specified in this section to be performed by the isolation manufacturer or his representative and for coordination of all phases of the work.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel.

1.6 DESIGN REQUIREMENTS

- A. Design isolators and restraints for equipment installed outdoors to provide site specific restraint to withstand wind loads as calculated in accordance with ASCE 7, applied to any exposed surface of the isolated and/or restrained equipment. Isolators and restraints for outdoor equipment shall have bolt holes for attachment to the equipment and to the supports. Equipment shall be anchored to roof curb or rail, and roof curb or rail shall be anchored to the building structure.

1.7 COMPONENT MANUFACTURER'S RESPONSIBILITIES

- A. Vibration isolation component manufacturer shall have the following responsibilities:
1. Determine vibration isolation sizes and locations.
 2. Furnish vibration isolation systems as scheduled or specified.
 3. Guarantee specified isolation system deflection.
 4. Provide installation instructions, drawings and field supervision to assure proper installation and performance. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the manufacturer's representative. Upon completion of installation and after system is put into operation, representative shall make a final inspection and submit report to Architect in writing certifying that the installation is in compliance with reviewed submittal data.

1.8 COORDINATION

- A. Coordinate work with other trades to avoid having isolated systems coming in contact with the building. Inform other trades following this work to avoid causing any contact which would reduce the vibration isolation.
- B. Coordinate size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pad.
- C. Bring to the Architect's attention in writing prior to installation any conflicts with other trades which will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.
- D. Bring to the Architect's attention in writing any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.9 INSPECTION AND INSTRUCTION

- A. Notify the isolation manufacturer's representative prior to the general installation of vibration isolation devices so that the isolation manufacturer's representative can instruct and demonstrate the proper installation procedures with the Contractor's foremen.
- B. Comply with written instructions from the isolation manufacturer's representative as to the proper installation and adjustment of vibration isolation devices.
- C. Obtain inspection and approval from the isolation manufacturer's representative of the completed installation. Perform all work and make all adjustments as directed by the isolation manufacturer's representative as a result of the inspection.
- D. Obtain inspection and approval from the isolation manufacturer's representative, and perform all directed work and adjustments, of any installation to be covered or enclosed prior to such closure.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries

B. General:

1. Clean and paint steel components, and zinc-electroplate all nuts, bolts and washers. Clean structural steel bases of welding slag and prime with zinc-chromate or metal etching primer.
2. All springs installed out-of-doors shall be cadmium plated, zinc electroplated or powder-coated, hardware and other metal parts installed out-of-doors shall be galvanized, zinc electroplated or cadmium plated. Non Electro-Plated zinc coating shall be by hot dipped galvanizing and shall comply with ASTM-B17 salt spray test standards and Federal Test Standard No. 14.
3. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
4. Isolator types are scheduled to establish minimum standards. At Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the isolation performance of the isolators.
5. All static deflections stated are not "minimal" or "rated" deflections, but are the minimum acceptable deflection for the mounts under actual load as certified by the manufacturer. Isolators selected solely on the basis of rated deflections are not acceptable and will be rejected.
6. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of compressed height of spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1/1. All mounts shall have leveling bolts.
7. All elastomeric isolation elements shall be fabricated of neoprene or high quality synthetic rubber with anti-ozon and antioxidant additives, and shall be cured to eliminate curing outgassing. The formulation shall have a shore hardness of 30 to 60 ± 5 , after minimum aging of 20 days or corresponding oven-aging. Elements used in restraints shall be bridge-bearing quality.

C. Pads:

1. Type NP (Neoprene Pad – ASHRAE Type 1):
 - a. One layer of 1/4 inch to 3/8 inch thick ribbed or waffle-pattern neoprene. Pads sized so that they will be applied within manufacturer's supplied application Engineering data.

D. Spring Isolators, Type FSN (Floor-Spring-Neoprene): Freestanding, laterally stable, combination coil-spring and elastomeric isolator with spring and insert in compression (ASHRAE Type 3).

1. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
 2. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not mounted on a housekeeping pad, and may be zinc- grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
 3. If isolator is to be fastened to the building structure and a Type NP isolator is used under the bearing plate, provide grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 8. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 9. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. Restrained Spring Isolators, Type FSNTL (Floor-Spring-Neoprene, Travel Limited): Freestanding, laterally stable, combination coil-spring and elastomeric-insert isolator with seismic or limit-stop restraint (ASHRAE Type 4).
1. All mounts shall have leveling bolts and vertical travel limit stops to control extension when weight is removed. Travel limit stops shall be capable of serving as blocking during erection of equipment. Maintain a maximum clearance of 1/4 inch around restraining bolts and between limit stops and spring to avoid interference with spring action.
 2. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load pad uniformly within the manufacturer's recommended range.
 3. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not mounted on a housekeeping pad, and may be zinc- grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
 4. If isolator is to be fastened to building structure and a Type NP isolator is used under the bearing plate, provide neoprene grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
 5. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

6. Restraint: Seismic and wind or limit stop shall comply with site specific design parameters as defined by applicable code.
 7. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 8. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 9. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 10. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. Elastomeric Hangers Type HN (Hanger-Neoprene): Single or double-deflection type compression hanger (ASHRAE Type 2).
1. General: Fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Provide neoprene neck bushing where hanger rod passes through the hanger housing to prevent rod from contacting hanger housing. Make diameter of hole in housing sufficient to permit hanger rod to swing through a 30° arc before contacting hanger housing.
- G. Spring Hangers Type HSN (Hanger Spring Neoprene): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression (ASHRAE Type 3).
1. General: Vibration isolation hangers consist of a freestanding, laterally stable steel spring and a neoprene element in series, contained within a steel housing. Make spring diameters and hanger housing lower hole sized large enough to permit hanger rod to swing through a 30° arc before contacting housing or make equivalent alternative provisions to allow specified movement.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene with a 0.3 inch minimum static deflection. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- H. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- I. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

- J. Resilient Penetration Sleeve/Seal: Field fabricate from pipe or sheet metal section 1/2 inch to 3/4 inch larger in each dimension than penetrating element in all directions around the element. Use to provide a sleeve through construction penetrated. Extend sleeve 1 inch beyond penetrated construction on each side. Pack annular space between sleeve and the penetrating element tightly with glass fiber or mineral wool to within 1/4 inch of ends of sleeve. Fill remaining 1/4 inch space on each side with acoustical sealant to form an airtight seal. Penetrating element shall be able to pass through sleeve without contacting sleeve. Alternatively, prefabricated sleeves accomplishing same result are acceptable.
- K. Grommets: Apply a formed grommet to prevent bolts from directly contacting the isolator base plate and sized so that they will be loaded within the manufacturer's recommended load range.

2.2 NON-RESTRAINED, NON-ISOLATED ROOF CURB (Type BC-4)

- A. Acceptable Manufacturers:
 - 1. Roof curb manufacturer shall be the responsibility of the roof-mounted equipment manufacturer.
- B. General: Requirements for Non-Restrained Non- Isolated Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to support equipment and to withstand wind forces.
- C. Lower Support Assembly: Formed sheet-metal section that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- D. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building structure. Details of anchoring requirements shall be provided by the Curb supplier.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials. Weather protect each spring isolator.
- F. Pitched Roof: Fabricate roof curb with tapered bottom designed to match roof slope where required whether or not indicated on drawings.
- G. Connections: All wiring and duct connections made within perimeter of roof curb.

2.3 VIBRATION ISOLATION ROOF RAIL (Type RIRS)

- A. Acceptable Manufacturers:
 - 1. Mason Industries
 - 2. Kinetics Noise Control

- B. General: Prefabricated assembly consisting of continuous equipment support piers and steel spring isolation system that forms the support under isolated equipment.
- C. Spring Isolators: Adjustable, restrained spring isolators (Type FSNTL-SR) shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- D. Support Piers: Construct equipment support pier of galvanized steel or plaster coated steel, straight base section without cant strip and with integral base plate, all welded construction, internal reinforcement, treated wood nailer. Provide clearance above roof surface as per requirements by the National Association of Roofers recommendation for maintenance and re-roofing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and wind-restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after non-conforming code compliance conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Provide vibration isolators of appropriate sizes and proper loading to meet specified deflection requirements. Select in accordance with the weight distribution to provide uniform isolator load distribution.
- B. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet requirements stated herein, even if not expressly specified or shown on Drawings, without claim for additional payment.
- C. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- D. Should any rotating equipment cause excessive noise or vibration when properly installed on the vibration isolators, and if it is caused by isolator, then the isolation manufacturer shall be responsible for rebalancing, realignment or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for unit in question.
- E. Make certain that attachments do not short circuit the isolation system and that isolation system is unrestrained. Special attention shall be applied in the installation of restraints on thermally active

piping systems as this condition can shorten out vibration isolation devices and impose excessive stress on the structural components.

- F. Adjust isolators after piping system is at operating weight.
- G. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- H. Adjust active height of spring isolators.
- I. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.3 VIBRATION ISOLATION, APPLICATION

A. General

- 1. The static deflections of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment

- 1. Unless otherwise shown or specified, set all floor mounted major equipment on 4 inch high housekeeping type concrete pad properly doweled or bolted to floor to meet site specific anchoring forces. Size pad to extend far enough beyond restraint to develop full rating of restraint in accordance with isolation manufacturer's instructions.
- 2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as scheduled elsewhere in this section.
- 3. Provide thrust restraints on equipment as called for in the schedule or as specified or as required whether or not scheduled or specified to limit movement to 1/4 inch maximum. As a minimum, provide thrust restraints for all suspended fans, all suspended or floor mounted axial flow fans and for other floor mounted fans developing 4 inches or more static pressure, unless the horizontal component of the thrust force can be demonstrated to be less than 10% of the equipment weight. Install thrust restraints on the discharge of the fan so that the restraint rods are in tension. Assemblies that place the rods in compression are not acceptable.

C. Miscellaneous Mechanical Equipment

- 1. Isolate the following miscellaneous pieces of mechanical equipment which are connected to isolated piping systems from the building structure:
 - a. Storage Tanks
- 2. Isolate miscellaneous mechanical equipment listed with Type NP or Type HN isolators, selected for 0.1 inch static deflection unless their position in piping system requires a higher degree of isolation as called for under piping isolation.

D. Pipe Isolation

1. All chilled water, condenser water, refrigerant, and drain piping shall be isolated from the building structure within the following limits:
 - a. Within mechanical rooms;
 - b. Within 50 foot total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, etc.);
 - c. All above piping that is 6 inches or larger shall be isolated everywhere.
2. Piping shall be isolated from building structure by means of vibration isolation, resilient lateral supports and, except at penetration through fire-rated construction, resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall have the same deflection as used on the connected equipment isolation. When the required static deflection of these isolators is greater than 1/2 inch, Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2 inch, Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving not less than 1/4 inch static deflection.

E. Ductwork

1. Isolate all sheet metal ducts and air plenums within mechanical rooms or within a distance of 50 feet total duct length of connected vibration isolated equipment (whichever is longer) from the building structure by either Type FN, PCF or HN isolators (whichever is applicable to mounting condition). All isolators shall achieve not less than 0.1 inch static deflection.
2. Isolate ducts within the specified limits that penetrate nonfire-rated building construction from the building by use of resilient penetration sleeve/seals.
3. Use resilient lateral supports wherever lateral support of vertical duct runs is required within the specified areas.

3.4 VIBRATION ISOLATION, INSTALLATION

A. General

1. Select locations of all vibration isolation equipment for ease of inspection and adjustments, as well as for proper operation.
2. Install vibration isolation equipment in accordance with isolation manufacturer's written instructions.
3. Prior to startup, verify that there are no isolation short circuits.
4. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Isolators

1. Align all vibration isolators squarely above or below mounting points of supported equipment.
2. Locate isolators for equipment with bases on the side of the bases which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability

of supported equipment, whether or not such a base is specifically called for herein or shown on the drawings.

4. If a housekeeping pad is provided, isolators and the isolator base plate must rest entirely on pad.
5. For steel framed structures, connect hanger rods for vibration isolated support to structural beams or joists, not to floor slab between beams and joists. Provide intermediate support members and joist reinforcing members as necessary.
6. Position vibration isolation hanger elements as high as possible in hanger rod assembly, but not in contact with building structure, so that hanger housing may rotate a full 360° about rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze which is isolated from building. Deflections must be largest determined by provisions for pipe isolation. Do not hang isolated and nonisolated pipes on same trapeze.
8. Do not support pipes, ducts or equipment from other pipes or equipment.
9. Resiliently isolated pipes shall not contact building construction or other equipment.
10. The installed and operating heights of isolated equipment mounted on Type FSNTL isolators or Type BC-1 bases shall be the same. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4 inch clearance between limit stop brackets and isolator top plate, and between travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting ducts or pipes. Leveling bolts shall not be used to level equipment if unevenness exceeds 1/8 inch as measured by the longest dimension of the equipment base. If leveling of equipment requirements are greater than 1/8 inch, grouting of the base shall be used in order to achieve a level equipment mounting platform.

C. Bases

1. Equipment shall not bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by equipment manufacturer. This provision applies whether or not a base frame is called for on the schedule. In the case that a base frame is required for equipment because of equipment manufacturer's requirements and a base frame for the equipment is not specifically called for on equipment schedule, Contractor for Division 23 shall provide the base frame recommended by equipment manufacturer at no additional expense.
2. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch between steel rails, steel frame bases or inertia bases and the concrete housekeeping pad or floor beneath the equipment. Position isolator mounting brackets so that required clearance is maintained. Check and clean clearance space to ensure that no construction debris has been left to short-circuit or restrict proper operation of vibration isolation system.

D. Vibration Isolation Thrust Restraints: Attach thrust restraints at the vertical centerline of thrust on each side of the unit, and so that thrust rods are in tension only. Install the two rods of the thrust restraint parallel to the thrust force. This may require modified brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Adjust restraints to constrain equipment movement to the specified limit.

E. Resilient Penetration Sleeve/Seals: Install penetration seals to maintain an airtight seal around penetrating element and to prevent rigid contact of penetrating element and building construction. Fit sleeve tightly to building construction and seal airtight on both sides of construction penetrated with acoustical sealant.

- F. Grommets: Where grommets are required at hold-down bolts of isolators, properly size bolt holes to allow for grommets. The hold-down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized for galvanized isolators and stainless steel elsewhere.

3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of all vibration isolation devices, the isolation manufacturer's representative shall inspect the installation and certify in writing to the Contractor that all isolation devices are installed in compliance with the written quality assurance document as furnished by the isolation manufacturer.

3.6 HVAC VIBRATION-ISOLATION DEVICE SCHEDULE

VIBRATION ISOLATION SCHEDULE				
Equipment	Base Type	Isolator		Remarks
		Type	Defl. (In)	
Indoor Air Handling Unit (AHU-_)	-	NP	0.25	(1)
Indoor Air Handling Unit (AHU-_)	-	FSNTL	1.50	
Chiller, Outdoor Roof Mounted (CH-_) (P-_)	-	FSNTL	1.0	
Suspended Fans (EF-_)	None	HSN	1.5	
Condensing Unit (Outdoor) (CU-_)	RIRS	FSNTL	1.5	
Fan Coil Unit, Suspended	-	HSN	0.75	
Unit Heater, Suspended	-	HN	0.25	
Curb Mounted Fans (Non-Isolated)	BC-4	-	-	

- (1) Fans(s) internally isolated by AHU Manufacturer. Include thrust restraints.
 (2) Isolate with connected piping.

END OF SECTION 23 05 40

SECTION 23 07 00 - HVAC 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. HVAC Piping Insulation
2. HVAC Duct Insulation
3. HVAC Equipment Insulation
4. Adhesives, mastics, tapes

B. Related Sections

1. Pipe insulation insert and shields are specified in Section 23 05 00, "Common Materials and Methods for HVAC".

1.3 DEFINITIONS

- A. Cold Surfaces: Normal operating temperatures less than 75° F.
- B. Density: Is expressed in pcf (pounds/cu. ft.) (kg/m^3).
- C. Dual Temperature Surfaces: Normal operating temperatures that vary from hot to cold.
- D. Hot Surfaces: Normal operating temperatures of 100° F or higher.
- E. Thermal Conductivity ("k" value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of $(\text{Btu} \times \text{inch})/(\text{h} \times \text{sq. ft.} \times ^\circ\text{F})$ ($\text{W/m} \times ^\circ\text{C}$).
- F. Through Resistivity ("R" value): Represents the reciprocal of thermal conductivity ("k" value).

1.4 REFERENCES

- A. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- B. ASTM E84 Surface Burning Characteristics of Building Materials.

- C. MICA Standards: National Commercial & Industrial Insulation Standards published by the Midwest Insulation Contractors Association. Endorsed by National Insulation Contractors Association (NICA) and its regional associations.
- D. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
- E. NFPA 255 Test of Surface Burning Characteristics of Building Materials.
- F. UL 723 Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, as applicable).
- B. Product Schedule or List: Prepare a summary of products required and clearly indicate location of their intended use.
- C. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

1.6 QUALITY ASSURANCE

- A. Materials, job conditions and installation shall be in compliance with the applicable Building and Mechanical Codes and NFPA 90A.
- B. Installation shall be done in a workmanlike manner by skilled and experienced workers who are regularly employed in commercial/industrial insulation work, in accordance with manufacturer's recommendations and instructions and best practices of the trade.
- C. Comply with the more stringent of the requirements of this specification or the requirements of the MICA standards.
- D. Insulation materials manufacturing facilities must be certified and registered with an approved registrar for conformance with ISO 9000 quality standard.
- E. Fire Performance Characteristics
 - 1. Insulation, jacketing materials, PVC covers, tapes, adhesives, mastics, cements and finish coatings shall have a composite noncombustible fire and smoke hazard rating and label, as tested in accordance with United States Public Health Service requirements, ASTM E84, NFPA 255 and UL 723 not exceeding Flame Spread 25 and Smoke Developed 50.
 - 2. Indoor Recovering Canvas Jackets: UL listed fabric, 6 ounce per square yard, unless otherwise specified, attached with a lagging fire retardant and waterproof adhesive.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Deliver materials to job site in original unbroken factory packaging, labeled with manufacturer's density and thickness and store in a safe, dry place.
- B. No insulation material shall be installed that has become damaged in any way.
- C. Do not install, and remove from the site, any insulation material that has become wet because of transit or job site exposure to moisture or water. Remove insulation from ductwork, piping and/or equipment which has become wet. Reinsulate as required.

1.8 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Common Materials and Methods for HVAC."
- B. Coordinate clearance requirements with installing contractor for insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

- A. Schedule insulation application after pressure testing of piping and duct systems. Insulation application may begin on segments that have satisfactory test results.
- B. Schedule insulation application on chilled water piping prior to circulating chilled water and schedule application on supply air ductwork prior to delivering conditioned air. Do not install insulation to surfaces where condensation is present.
- C. Do not install any insulation before building is adequately closed in. Where it is necessary to install insulation in any section of building that is not adequately closed in, secure prior permission and, where permission is granted, such insulation shall be in place to form a waterproof covering. Remove and replace all insulation installed that becomes water saturated because of failure to comply with this requirement, at no increase in the Contract sum.

1.10 ALTERNATIVES

- A. Alternative insulations are subject to Architect's approval. Alternatives shall provide, at normal conditions, thermal resistance within 5% of resistance of materials specified.
- B. Where alternative thermal conductivity ("k") differs from specified thermal conductivity by more than 5%, increase or decrease insulation thickness as follows:

$$\text{New Thickness} = \frac{\text{Actual "k"}}{\text{Specified "k"}} \times \text{Specified Thickness}$$

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armacell
3. Owens-Corning Fiberglass
4. Knauf Insulation
5. Certain Teed

B. Insulation Type P1:

1. Piping: Fine fibrous glass insulation, with factory applied vapor barrier jacket, molded to conform to piping, "k" value at 75° F maximum 0.23. Johns Manville "Micro-Lok AP-T Plus" with jacket of white Kraft reinforced with fiberglass yarn and bonded to aluminum foil, and having a pressure sensitive tape closure system bonded to the longitudinal lap.
2. Valves and Fittings:
 - a. Glass fiber insert of equal thickness to adjacent pipe insulation and premolded PVC cover, Johns Manville "Zeston" and "Hi-Lo Temp Inserts" for valves and fittings.
 - b. Factory molded fibrous glass fitting covering for fittings of equal thickness to adjacent pipe insulation. Cover with 6 ounce canvas on concealed piping and 8 ounce canvas on exposed piping.
 - c. Mitered sections of pipe covering for valves.

C. Insulation Type P2:

1. Piping: Type P1 with additional aluminum jacket of Alloy No. 5005 or No. 3003 with minimum thickness of 0.016 inches. Johns Manville "Micro-Lok ML".
2. Valves and Fittings: Mitered sections of Type P2 piping insulation with miter seals and snap-straps.

D. Insulation Type P3:

1. Piping: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum water vapor transmission rating of 0.05 perms. Insulation shall not drip or melt when exposed to flame. Polyethylene or polyolefin not allowed. Armacell "AP Armaflex", "AP Armaflex SS" and "AP Armacell W" (maximum 0.2 perms). Exposed insulation in finished areas shall be white.
2. Valves and Fitting: Mitered sections of Type P3 insulation. Factory produced or field fabricated.

2.2 EQUIPMENT INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armacell
3. Owens Corning
4. Knauf

B. Insulation Type E1 - Cold Equipment: Rigid fibrous glass insulation, density approximately 3 pcf, with factory applied reinforced aluminum foil vapor barrier, "k" value at 75° F maximum 0.23. Johns Manville "814 Spin- Glas" with FSK jacket.

C. Insulation Type E4 – Cold Equipment: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum vapor transmission rating of 0.05 perms. Armacell "AP Armaflex Sheet Roll" and "AP Armaflex SA Sheet".

2.3 DUCTWORK INSULATION

A. Acceptable Manufacturers:

1. Johns Manville
2. Armacell
3. Owens Corning
4. Knauf
5. Certain Teed

B. Insulation Type D1: Semirigid fibrous glass ductwork and casing insulation, density approximately 4 pcf with factory applied reinforced aluminum foil vapor barrier, "k" value at 75° F maximum 0.23. Johns Manville "815 Spin-Glas" with FSK jacket.

C. Insulation Type D2: Flexible fibrous glass ductwork insulation with factory applied reinforced aluminum foil vapor barrier, density approximately 0.60 to 0.75 pcf, "k" value at 75° F maximum 0.31 Johns Manville "Microlite" with Type FSK jacket.

D. Insulation Type D3: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum vapor transmission rating of 0.05 perms. Armstrong "AP Armaflex" and "AP Armaflex SA".

PART 3 - EXECUTION

3.1 PREPARATION

A. Determine clearances required for installation of work and review such requirements with trades responsible for installing various piping systems, ducts and equipment to be insulated. Where it is determined that working clearances between equipment and material to be insulated and adjacent work will restrict or prohibit proper installation of work, immediately report such conditions to all interested

parties and arrange to have affected material relocated or preinsulated before erection, as approved. Failure to so comply will not relieve Contractor of full responsibility for providing specified insulation.

- B. Do not install covering before piping, ductwork and equipment has been tested and approved, or before ductwork has been sealed.
- C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with applicable requirements of Division 23 Section, "Common Materials and Methods for HVAC".
- B. Adhesives and mastics materials shall be compatible with insulation material, jackets and substrates. Apply insulation and adhesives in accordance with manufacturers' instructions.
- C. Clean excess adhesive, mastic or cement used in performance of work from all exposed surfaces of insulation jacketing materials. Clean smudges and dirt from all exposed surfaces of insulation jacketing materials at conclusion of this work.
- D. Apply insulation on all cold surfaces with a continuous, unbroken vapor seal. Install hangers outside of insulation for all piping subject to sweating (e.g., chilled water supply and return, refrigerant suction, dual temperature water supply and return, drain piping for air conditioning equipment, glycol heat recovery piping, etc.) and provide inserts - refer to and coordinate with Section 23 05 00, Part 3, Article titled "PIPING SYSTEMS – COMMON REQUIREMENTS", paragraph titled "Pipe Insulation Inserts and Shields". For all equipment subject to sweating, insulate and vapor seal hangers, supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.
- E. Extend all surface finishes to protect all surfaces, ends and raw edges of insulation.
- F. Install insulation on and at access doors to allow easy use of access door without damage to insulation.
- G. Finish insulation neatly at hangers, supports and other protrusions.
- H. Install insulation with least number of joints practical. Locate insulation, or cover seams, in least visible locations.
- I. Finish installation with systems at operating conditions. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- J. Be responsible for proper curing of insulation, etc., in accordance with manufacturers' requirements.

3.3 PENETRATIONS

- A. Refer to Division 23 Section "Common Materials and Methods for HVAC" for additional requirements.

- B. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Non-Rated Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.
- E. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Carry pipe insulation through sleeves and through hangers which are specified to be installed outside insulation.
- C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings 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.

3. 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.
 4. 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.
 5. 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.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
 9. Insulate flexible connections and expansion joints on cold piping with removable insulation section. Install insulation on flanges, valves and unions so that it can be removed and replaced without damaging adjacent insulation.
- D. Terminate insulation neatly and finish all exposed ends with plastic material troweled on bevel.
- E. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- F. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless- steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover

assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

G. Insulation Type P1

1. Seal longitudinal laps of jackets and wrap butt joints with 3 inch wide strip of jacketing material securely sealed in place.
2. Where premolded PVC fitting covers are used, apply factory precut insulation insert in accordance with manufacturer's instructions and then apply one piece cover. Use two or more layers of inserts on hot piping as required to limit outer surface temperatures of insert(s) to 150° F maximum. Use two layers of inserts on chilled water and refrigerant piping. On concealed hot piping, covers may be secured with staples. On exposed hot piping, secure covers by taping ends to adjacent insulation. Seal seam edges of covers on concealed and exposed cold piping with Zeston vapor-barrier adhesive and wrap edges of covers with Zeston vapor-barrier pressure sensitive color matching tape.
3. Where factory-molded fibrous glass fitting covering is used, finish insulation on concealed and exposed hot piping with same jacketing material as adjacent insulation lap- sealed and finished with Foster 30-36, Childers CP-50A or equal. Finish insulation on cold piping same as for hot piping except that sealer shall be Foster 30-35 or Childers CP-30LO vapor sealer.
4. Finish valve covering in hot and cold piping systems same as specified above for fittings.
5. Recover exposed piping in finished areas with 0.02 mil thick PVC jacket and less than 8 ft above floor in mechanical room with 0.02 mil thick PVC jacket or aluminum jacket, except use Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, adhered and then finished with Foster 30-36 or Childers CP- 50A at steam pressure reducing stations and when piping systems are specified to be painted.

H. Insulation Type P2

1. Secure metal jacket in place by a continuous longitudinal friction type joint. Seal circumferential joints with 2 inch wide, .016 inch aluminum preformed snap-strap and clip containing a permanently plastic weatherproof sealant. Where outside diameter of the insulation is over 12-3/4 inches, lock snap-strap in place using 3/4 inch wide, .015 inch thick, No. 302 stainless steel bands. Apply snap-strap with appropriate banding wrench.
2. Use mitered sections of metal jacketed insulation for valves and fittings. Seal joints with sealing compound and preformed aluminum bands.
3. Entire installation of metal jacketed insulation shall be weatherproof.

I. Insulation Type P3

1. Where possible, slip insulation over tubing as a full cylinder. Push insulation on to pipe. Do not pull insulation on pipe. Where necessary to longitudinally cut, and at all butt joints, tightly butt edges and join by sealing with waterproof vapor barrier adhesive, Armaflex 520. For Self-Seal type, peel adhesive paper from surface and apply firm pressure along entire longitudinal joint.
2. Cover fittings and valves with equivalent thickness of insulation material.
3. Finish outdoor insulation with two coats of manufacturer's recommended weather- resistant and ultraviolet-resistant protective finish: Armacell WB Armaflex, white. DO NOT TINT FINISH.
 - a. At Contractor's option (for all outdoor piping), use aluminum jacket, as specified for insulation Type P-2.

- b. Secure metal jacket in place by a continuous longitudinal friction type joint. Seal circumferential joints with 2 inch wide, .016 inch aluminum preformed snap-strap and clip containing a permanently plastic weatherproof sealant. Where outside diameter of the insulation is over 12-3/4 inch, lock snap-strap in place using 3/4 inch wide, .015 inch thick, No. 302 stainless steel bands. Apply snap-strap with appropriate banding wrench.
- c. Use mitered sections of metal jacketed insulation for valves and fittings. Seal joints with sealing compound and preformed aluminum bands.
- d. Entire installation of outdoor piping shall be weatherproof.

3.5 PIPING INSULATION SCHEDULE

Service Temp	Systems Description	Indoor			Outdoor or Unheated Space			
		Type	Pipe Size	Thickness	Type	Pipe Size	Thickness	Heat Trace
40-60F	Chilled Water	P1 or P3	≤ 3/4"	1"	P2 or P3	≤ 3/4"	2"	Yes
			1" to 1 1/2"	1 1/2"		1" to 1 1/2"	2 1/2"	
			≥ 2"	2"		≥ 2"	2 1/2"	
40-60F	Condensate Drain (Cooling Coil, Heat Recovery Coil, Heat Pump)	P1 or P3	≤ 1 1/4"	1/2"	P3	All	2"	Yes
			≥ 1 1/2"	1"				
	Refrigerant Liquid	-	-	-	P3	All	3/4"	
<40F	Refrigerant Suction	P3	≤ 3/4"	1 1/2"	P3	≤ 3/4"	1 1/2"	
			≥ 1"	2"		≥ 1"	2"	

- Note:
1. Insulation for underground piping systems is specified in Section 23 24 13.
 2. Outdoor or Unheated Space insulation thickness shall extend through wall inside the building or heated space minimum of 2 feet.
 3. Insulation can be omitted from Condenser Water System located indoors in mechanical rooms and in spaces within buildings that are not humidified only when approved by Architect/Engineer.
 4. Where systems are required that don't exactly match the systems description listed on the schedule, provide insulation based on the appropriate service temperature range.

3.6 INSTALLATION, EQUIPMENT

- A. Apply insulation with edges tightly butted and joints staggered. Provide sufficient clearances around opening for normal operation of equipment. Do not cover cleanouts and nameplates, and bevel insulation at such openings.
- B. Insulation Type E1: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches on center in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
11. Seal all joints with vapor barrier mastic, Foster 30-35, Childers CP-30LO or equal. Over insulation apply tack coat of Foster 30-36, Childers CP-50A or equal, and imbed into wet coating Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, Childers "Chil-Glass" or equal, smoothing to avoid wrinkles, and overlapping all seams at least 2 inches. Apply finish coat of Foster 30-36, Childers CP-50A or equal.
12. When applying to hot equipment, bring insulation up to operating temperature and provide space ventilation in accordance with manufacturer's recommendations.

C. Insulation Type E4

1. Install using manufacturer's recommended adhesive (Armacell 520). Use full adhesive coverage attachment, including seams and joints. Coat both surfaces to be joined. Seal longitudinal seams and end joints.

2. Finish outdoor insulation with two coats of manufacturer's recommended weather-and ultraviolet-resistant protective finish Armacell WB Armaflex, white. DO NOT TINT FINISH.
 - a. At Contractor's option (for outdoor insulation), use manufacturer's factory applied UV resistant jacket adhered to Type E4 insulation. Armacell Armatuff Plus.
- D. Removable Insulation: For strainers, casings of pumps handling chilled, etc., which require access for service and maintenance, provide insulated removable and replaceable 20 gauge galvanized steel cover painted with Foster 30-35. Apply insulation to all inside surfaces of cover using adhesive as recommended by insulation manufacturer. Seal all seams and joints to provide vaportight enclosure for indoor equipment and weathertight for outdoor equipment. Provide flanged joint, gasketed and bolted, for convenient removal and replacement.
- E. Insulation Installation on Pumps: Adhere insulation Type E4 directly to pump casing. Joints shall coincide with splits in pump casing. Provide removable insulation piece at pump nameplate. Do not insulate over drain and vent tapings.

3.7 EQUIPMENT INSULATION SCHEDULE

Equipment	Type	Thickness
Air Separator (Chilled Water, Condenser Water)	E1 or E4	1 1/2"
Chilled Water Storage Tank	E1 or E4	2"
Chilled Water Expansion Tank, Chemical Treatment Feeder	E1 or E4	1"
Heat Exchanger (Chilled Water, Cooling Water)	E4	1 1/2"
Pump Casing (Chilled Water, Dual Temperature, Glycol Heat Recovery)	E4	1"
Water Chiller (Not Factory Insulated) - Evaporator Shell, Heads, Water Boxes	E4	2"

3.8 DUCTWORK AND CASINGS INSULATION INSTALLATION

A. Insulation Type D1:

1. Apply with edges tightly butted. Impale on pins welded to duct and secure with speed clips. Cut protruding ends of pins flush. Space pins as required to hold insulation firmly in place but not less than one pin per square foot. Seal all joints, exposed ends, speed clips and penetrations of

- the vapor barrier with minimum 3-inch-wide strip of the vapor barrier material applied with Foster 85-75 or Childers CP-82 to both surfaces or with pressure sensitive tape to match facing.
2. Outdoor Installation: Cover with sheet metal jacketing; minimum 26 gauge aluminum in conformance with ASTM B209M, having lock forming corner bead and joint capability. Interlocking seams and corner beads completely sealed and made watertight.

B. Insulation Type D2

1. Cut insulation to length longer than duct perimeter to minimize compression and maximize installed "R" value as recommended by manufacturer. Allow maximum fullness at corners of rectangular ductwork and avoid excessive compression.
2. Insulation shall be firmly butted at all joints with a maximum allowable compression of 25%. Secure insulation to underside of ducts 18 inches or greater in width with mechanical fasteners welded to duct and speed clips spaced approximately 18 inches on center. Cut protruding ends of pins flush. Additionally secure to sides of ducts 18 inches or greater in depth and to the two larger sides of all vertically installed ductwork with mechanical fasteners in the same fashion as for the underside of ducts 18 inches or greater.
3. Overlap all joints at least 2 inches and staple in place. Seal stapled seams, speed clips and breaks in the vapor barrier facing with a minimum 3-inch-wide pressure sensitive tape designed for use with the duct insulation. Use pressure sensitive tape and apply additional Foster or Childers sealant in concealed spaces to provide a complete sealed thermal break installation.

C. Insulation Type D3

1. Verify that horizontal rectangular ductwork is properly pitched to avoid ponding before installing insulation.
2. Install using manufacturer's recommended adhesive (Armacell Armaflex 520). Metal surface must be clean and dry before application. Use full adhesive coverage attachment, including seams and joints. Coat both surfaces to be joined. Apply pressure to the surface of the insulation to assure a tight bond. Make sure all joints are under compression.
3. Install on each surface and butt joint at corners. Do not continuously wrap around corners on rectangular duct causing insulation to be in tension.
4. Outdoor Installation: Finish, using manufacturer's recommended procedures, with two coats of manufacturer's recommended weather-resistant and ultraviolet-resistant finish (Childers Vi-Cryl CP-10 white, with elastic reinforcing cloth (Vimasco Dynel Elastafab #894 8 x 8 mesh) blended into the first coat. **DO NOT THIN THE MASTIC.** Overlap seams of reinforcing cloth a minimum of 6 inches at each corner of rectangular ductwork. Completely cover mesh with second coat, applied immediately after the first coat has taken its set.

3.9 DUCTWORK AND CASING INSULATION SCHEDULE

A. Minimum Thickness

1. Insulation thickness indicated hereinafter in this article and/or on the drawings is minimum thickness. Where duct is constructed with flanged, angle, standing, factory fabricated or similar joints or reinforcing, increase thickness to provide minimum 1/4 inch cover on edge of joint or reinforcing.
2. Increased thickness section shall be a minimum of 6 inches wide, centered on flange or reinforcing with exposed ends sealed as specified in this article.

B. Type

1. Exposed Indoor Rectangular Ductwork - Type D1.
2. Concealed Rectangular Ductwork - Either Type D1 or Type D2 at Contractor's option.
3. Apparatus and Equipment Casings – Type D1 Indoors, Type D3 Outdoors
4. Indoor Round and Oval Ductwork - Type D2.
5. All Outdoor Ductwork - Type D3.

C. Thickness Schedule:

<u>Location</u>	<u>Thickness* - Type D1 and D3</u>	<u>Thickness* Type D2</u>
1. Equipment Casing		
a. Indoor (Type D1)	2 Inches	Not Allowed
b. Outdoor (Type D3)	3 Inches	Not Allowed
2. Ductwork Location		
a. Outdoors		
1) Supply air	3 Inches	Not Allowed
2) Return air	3 Inches	Not Allowed
3) Exhaust air	1-1/2 Inches	Not Allowed
b. Indoors (Type D1 or D2)		
1) Penthouse or Mechanical Room with Roof	1-1/2 Inches	Not Allowed
2) Air Conditioning Supply and Return Between Roof and Suspended Ceiling	1-1/2 Inches	2 Inches
3) Other Than Above	1 Inch	1-1/2 Inches

*Subject to compliance with Paragraph A. of this article, where ductwork or apparatus casing or equipment casing is acoustically lined, reduce insulation thickness by equivalent thickness of lining so that combined "R" of lining and insulation is equal to or greater than "R" of specified insulation thickness. Increase thickness at flanged or standing joints to provide minimum 1/4 inch cover over edge of flange or joint.

D. Listing of Ductwork and Casings to be Insulated:

1. All air conditioning system supply air ductwork, casings and plenums.
2. Air conditioning system return air ductwork, casings and plenums located in:
 - a. Mechanical equipment room.
 - b. Ceiling space or plenum where there is roof above.
 - c. Shaft with exterior wall(s) or shaft passing through non-air-conditioned space.
 - d. Non-air-conditioned space, including shaft not surrounded by air-conditioned spaces on all sides and ceiling space or plenum with non-air-conditioned space either above or below.
3. Air conditioning system return air ductwork, casings and plenums located outdoors.

4. Casings of heating and air conditioning systems and equipment which are not factory insulated, including plenums (supply, return, mixing), filter sections, access sections, sound attenuator casings and all other areas subject to condensation, heat gain or heat loss.
5. Combustion air duct.
6. Dryer exhaust ductwork.
7. Flexible ductwork not factory insulated.
8. Heating system supply ductwork, except ductwork exposed in spaces heated by the system.
9. Supply air diffuser plenums/back pans that are not either insulated or acoustically lined at the factory.
10. Ductwork and casings shown on the Drawings to be insulated, whether or not listed above.

END OF SECTION 23 07 00

SECTION 23 21 13 - HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Pipe, valves and fittings
 - 2. Strainers
 - 3. Hydronic System Specialties and Accessories
 - 4. Expansion Joints and Guides
- B. Related sections include:
 - 1. Hydronic flow meters are specified in Section 23 05 19 "Meters for HVAC".

1.3 PERFORMANCE REQUIREMENTS

- A. Design working pressure and temperature for all specialties and accessories suitable for system operating temperature and pressure 125 psig at 225° F minimum.

1.4 SUBMITTALS

- A. Product Data: For each type of factory fabricated item indicated, include pressure ratings, construction materials, data sheets, performance characteristics, and furnished accessories.
- B. Field quality-control test reports.
- C. Grooved joint couplings and fittings shall be shown on the drawings and product submittals and shall be specifically identified with the applicable style or series designation.

1.5 MANUFACTURER'S SUPERVISION/INSPECTION SERVICE

- A. Expansion Joints, Offset Type: Provide service of manufacturer's authorized representative to inspect installation and to submit report of his inspection to Architect.

- B. Flexible Pipe: Provide inspection services by manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and that connectors are performing satisfactorily.
- C. Grooved Installations: The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 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.
- D. Gaskets shall not contain asbestos.
 - 1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
- E. Conform to Standards of Expansion Joint Manufacturer's Association.
- F. All grooved joint couplings, fittings, valves and specialties shall be products of a single manufacturer. Grooving tools shall be of same manufacturer as the grooved component.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B88, Type K.

- C. DWV Copper Tubing: ASTM B306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22 for pressure fittings, ASME B16.29 for drainage fittings.
- E. Cast Brass Fittings: ASME B16.18 for pressure fittings, ASME B16.23 for drainage fittings.
- F. Flanges for Copper Tubing: Cast Bronze, ASME B11.24, Classes 150 and 300, solder joint.
- G. Grooved Mechanical Joint Fittings and Couplings: Victaulic Company "QuickVic" rigid coupling for copper manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.)
 - 1. Fittings: Wrought copper, ASME B16.22.
 - 2. Couplings:
 - a. Cast ductile iron conforming to ASTM A536. Copper-colored alkyd enamel coating for copper tubing systems. Coupling housings cast with offsetting, angle pattern bolt pads shall be used to provide system rigidity. Victaulic Style607.
 - b. Flange adapter; flat face for direct connection to ANSI Class 125/150 flanged components. Victaulic Style 641.
 - c. Gaskets composed of elastomer properties as designated by ASTM D2000. Gaskets for water service Grade "EHP", or as approved by the engineer for the specific service.
 - 3. Operating Conditions: -30° F through +250° F temperature range according to gasket or valve lining selected and working pressure as shown in manufacturer's current product specification.
 - 4. Coupling Assembly: Housing clamps in two parts, single C-shaped gasket, two or more electroplated steel bolts as required to assemble housing clamps.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; Type E, Grade B (electric resistance welded), wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Class 125 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Threaded Unions: ASME B16.39; Class 250 as indicated in Part 3 "Piping Applications" Article.
- E. Unions in Welded Steel Pipes 2 Inches and Smaller: Class 3000 carbon steel socket welding union steel to steel seat and ground joint. Stainless steel in stainless steel piping.

- F. Welded Fittings for Black Steel Pipe 2 Inches and Smaller: Forged steel socket welding fittings. ASTM A105 and ASME B16.11, wall thickness to match adjoining pipe. All elbows long radius.
- G. Welding Fittings for Black Steel Pipe 2½ Inches and Larger: ASTM A234/A234M and ASME B16.9, wall thickness to match adjoining pipe. All elbows long radius.
- H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- I. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.
- J. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts and nuts in accordance with applicable ASME standards. Flanges to be of slip-on, weld neck, threaded or solder type to suit piping system in which installed.
- K. Flange Gaskets: Flexitallic spiral wound gasket with PTFE filler and stainless-steel inner ring rated for 500° F service temperature. Gaskets shall be 1/8 inch thick, color coded and selected for service conditions.
- L. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products manufactured by the following manufacturers without substitution:
 - a. Victaulic Company of America.
 - b. Anvil/Gruvlok (sizes 14 inches and smaller).
 - 2. Operating Conditions: -30° F through +250° F temperature range according to gasket or valve lining selected and working pressure as shown in manufacturer's current product specification.
 - 3. Couplings
 - a. Cast of ductile iron conforming to ASTM A536. Alkyd enamel coating for black steel piping systems. Galvanized finish for galvanized piping systems. Couplings designed to engage and lock grooved or shouldered piping and fitting ends. Rigid joints in mechanical rooms, cooling tower piping and valve connections. Flexible coupling designed to allow for some angular deflection, contraction and expansion, may be used in distribution piping.
 - b. Sizes 2-1/2 inches through 12 inches: Coupling housings cast with offsetting, angle pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
 - c. Sizes 14 inch through 24 inches: Coupling housing key designed to fill the wedge shaped AGS groove and provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
 - d. Gaskets composed of elastomer properties as designated by ASTM D2000. Gaskets for water service Grade "EHP" EPDM, with green color code.

- e. Coupling Assembly: Housing clamps in two parts, single C-shaped gasket, two or more electroplated steel bolts as required to assemble housing clamps. Couplings with more than 2 parts are not acceptable.
 - f. Equal to Victaulic Styles 107 or W07, for rigid joints and Styles 177, 75, 77, or W77 for flexible joints.
4. Fittings: Full flow type fittings with grooves designed to accept couplings of the same manufacturer. ASTM A536 cast ductile iron, ASTM A234 forged steel, or ASTM A53 carbon steel, galvanized for galvanized piping systems.
 5. Where grooved mechanical joints are used, Contractor may use:
 - a. Grooved design strainers:
 - 1) T-Type 2-1/2 inches through 12 inches: 300 psi, ductile iron body, Type 304 stainless steel frame and removable mesh basket with No. 12 or No. 6 strainer sizes, 57% free open area. Victaulic Style 730.
 - 2) Y-Type: 300 psi, ductile iron body, Type 304 stainless steel perforated removable metal baskets with 1/16 inch or 1/8-inch diameter perforations. Victaulic Style 732
 - 3) T-Type 14 inches through 24 inches: 300 psi, AGS grooved end carbon steel body, Type 304 stainless steel frame and mesh basket with T-bolt hinged closure. Victaulic Style W730.
 - b. As a substitute for Butterfly Valves, Victaulic Master Seal for sizes 2-1/2 inch
 - c. through 12 inch, or AGS-Vic 300 for sizes 14 inches through 24 inches. Valve stem shall be offset from the disc centerline to provide full 360-degree circumferential seating. Gear operator for valves 6 inches and larger.
 - d. As a substitute for Spring Loaded, Lift Disc Check Valves; Victaulic Series 716 for sizes 2-1/2 inch through 12 inch and Series W715 for sizes 14 inch through 24 inch.
 6. USE OF GROOVED FLANGE ADAPTERS IS PROHIBITED. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.
- M. Steel Pipe Nipples: ASTM A733, made of same materials as pipe in which they are installed, Schedule 80.

2.3 VALVES, GENERAL REQUIREMENTS

- A. Valves are specified by valve type. Where more than one valve type is listed for a service, use any of the listed types, unless otherwise specified or indicated, but selection must be consistent throughout the work.
- B. Bronze Valves: NPS 2 and smaller with solder or threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Gear Drive: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
- J. Solder Ends: With sockets according to ASME B16.18.
 - 1. Caution: Use solder with melting point below 840° F for angle, check, gate, and globe valves. For ball valves and calibrated orifice balancing valves, manufacturers shall verify that valve construction is satisfactory for use with non-lead solders.
- K. Threaded Ends: With threads according to ASME B1.20.1.
- L. Valve Bypass and Drain Connections: MSS SP-45.
- M. Automatic Temperature-Control Valves, Actuators and Sensors: Comply with requirements specified in Division 25 Section "Instrumentation and Control for HVAC".

2.4 BRONZE ANGLE VALVES

- A. Acceptable Manufacturers:
 - 1. Type 2, Bronze Angle Valves:
 - a. NIBCO, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves
 - c. Milwaukee Valve Co.
 - d. Powell, Wm. Co.
- B. Bronze Angle Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Type 2, Class 150, Bronze Angle Valves: Bronze body with PTFE disc and union-ring bonnet. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM

B62 Alloy C83600 (Threaded) or Bronze ASTM B61. Forged or yellow brass bodies will not be accepted. NIBCO T-335-Y.

- D. Type 2, Class 300, Bronze Angle Valves: Bronze body with stainless steel disc, replaceable seat and union-ring bonnet. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM B62 Alloy C83600 (Threaded) or Bronze ASTM B61. Forged or yellow brass bodies will not be accepted. NIBCO T-376-AP.

2.5 CAST-IRON ANGLE VALVES

A. Acceptable Manufacturers:

1. Type II, Cast-Iron Angle Valves with Metal Seats:

- a. NIBCO, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves
- c. Milwaukee Valve Co

B. Cast-Iron Angle Valves, General: MSS SP-85, Type II.

C. Class 125, Cast-Iron Angle Valves: Bronze mounted with renewable seat and disc, gray-iron body and bronze seats. NIBCO F-818-B.

2.6 COPPER-ALLOY BALL VALVES

A. Acceptable Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves, NIBCO, Inc., series listed, or equivalent product manufactured by:

- a. Conbraco Industries, Inc.; Apollo Div.
- b. Crane Co.; Crane Valve Group; Crane Valves
- c. Metso; Jamesbury, Inc.
- d. Milwaukee Valve Company
- e. Watts Industries, Inc.; Water Products Div.
- f. Worcester

B. Copper-Alloy Ball Valves, General: MSS SP-110

- 1. Two-Piece, Copper-Alloy Ball Valves: Bronze body with full-port, stainless steel ball and trim; PTFE seats and packing; and 600-psig minimum CWP rating and blowout-proof stem. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM B62 Alloy C83600 (Threaded) or Bronze ASTM B61, ball and/or trim. Forged or yellow brass bodies will not be accepted. NIBCO T-585-70-66 and 5-585-70-66.

2.7 HIGH-PRESSURE (HIGH PERFORMANCE) BUTTERFLY VALVES

A. Acceptable Manufacturers: NIBCO, Inc. figure number listed or approved equal by:

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1. DeZurik
2. Crane Co.; Crane Valve Group; Flowseal
3. Metso; Jamesbury, Inc.
4. Posi-Seal
5. Tyco International, Ltd.; Tyco Valves & Controls; Keystone Valves

B. High-Pressure Butterfly Valves:

1. General: MSS SP-68. 6 inches and larger for Balancing Service, except not allowed for pump discharge or cooling tower balancing service 2½ inches or larger where used for shutoff service only, except not allowed for boiler shutoff service) for Hot or Chilled Water Service.
2. Butterfly valves to have full-lug carbon steel ASTM A216 lug body, one-piece stainless-steel stem with stainless steel bearings and stainless-steel disc manufactured in conformance with MSS SP-68, MSS SP-25, and API-609. Valve shall be capable of bi-directional dead-end service at full pressure rating of the valve with no downstream flanges required. Drive end of shaft to be designed to accept universal ISO 5211 Actuator Mounting top works. The stem journals will be a multiple seal design providing for completely independent seals. Positive stem retention to be provided using 316 stainless steel keys locked in place, to permit removal of handle or actuator while under full operating pressure. Design discs with an offset flat face to reduce dynamic torque, decrease turbulence and maximize flow capacity. Provide disc-to-shaft locking keys of stainless steel and of the tangential or compressive type. The valve seats to consist of replaceable PTFE seating surface with a stainless-steel retaining ring. Shaft and thrust bearings to be of combination permanently lubricated reinforced PTFE with 316 stainless steel. Provide packing of multiple PTFE and graphite V-ring design with adjustable stainless steel gland follower and gland.
3. Valves 3 to 6 inches to be supplied with multi-position, lever-lock handles; size 8 inch and larger to be supplied with gear operator. Valve body to be full-lug pattern to comply with MSS-SP-68 and be compatible with ANSI 150 or 300 pattern flanges of appropriate pressure rating. Similar to NIBCO series ANSI Class 150 LCS-6822-3, 3 to 6 inches; LCS-6822-5 8 inches and larger). ANSI Class 300 LCS 7822-3, 3 to 6 inches; LCS-7822-5 (8 inches and larger).

2.8 BRONZE CHECK VALVES

A. Acceptable Manufacturers:

1. Type 1, Bronze, Lift Check Valves with Metallic Disc:
 - a. NIBCO, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves
 - c. Milwaukee Valve Co.
2. Type 3, Bronze, Swing Check Valves with Metallic Disc:
 - a. NIBCO, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves
 - c. Milwaukee Valve Company

- B. Bronze Check Valves, General: MSS SP-80. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM B62 Alloy C83600 (Threaded) or Bronze ASTM B61. Forged or yellow brass bodies will not be accepted.

- C. Type 1, Class 125, Bronze, Horizontal or Vertical Lift Check Valves: Bronze body with PTFE disc and bronze seat. NIBCO T/S 480-Y.
- D. Type 1, Class 300, Bronze, Horizontal or Vertical Lift Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 473-B.
- E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 413-B.
- F. Type 3, Class 300, Bronze, Swing Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 473-B.

2.9 GRAY-IRON SWING CHECK VALVES

A. Acceptable Manufacturers:

1. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

- a. NIBCO Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Milwaukee Valve Co.

2. Grooved-End, Ductile-Iron Swing Check Valves:

- a. NIBCO, Inc.
- b. Mueller Co.
- c. Victaulic Co. of America.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

- C. Type I, Class 125, gray-iron, swing check valves with renewable metallic disc and seats. NIBCO F-918-B.
- D. Type II, Class 300, gray-iron, swing check valves with renewable metallic disc and seats. NIBCO F-968-B; Class 250 cast iron.
- E. 175-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends. NIBCO G-917-W; Cast Iron, Grooved, 250 psi, Swing Check; or KG-900-W; Cast Iron, Grooved, 250 psi, Silent Check.
- F. 300-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends and stainless steel disc and shaft. NIBCO KG-900-W-350; Cast Iron, Grooved, 350 psi, Silent Check.

2.10 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Acceptable Manufacturers:

1. Type III, Globe Lift-Disc Check Valves:

- a. NIBCO, Inc.
- b. Metraflex Co.
- c. Milwaukee Valve Company

2. Type IV, Threaded Lift-Disc Check Valves:

- a. NIBCO, Inc.
- b. Metraflex Co.
- c. Milwaukee Valve Company
- d. Mueller Steam Specialty

- B. Lift-Disc Check Valves, General: FCI 74-1 or MSS-SP-125 (Type III), with spring-loaded bronze, PTFE or alloy disc and bronze or alloy seat.
- C. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends. NIBCO F-910-W.
- D. Type III, Class 250, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends. NIBCO F-960-W.
- E. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends. NIBCO T-480.
- F. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends. NIBCO T-480.

2.11 BRONZE GLOBE VALVES

A. Acceptable Manufacturers:

1. Type 2, Bronze Globe Valves with Nonmetallic Disc:

- a. NIBCO, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves
- c. Milwaukee Valve Company
- d. Powell, Wm. Co.

2. Type 3, Bronze Globe Valves with Renewable Seats:

- a. NIBCO, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves
- c. Milwaukee Valve Company
- d. Powell, Wm. Co.

- B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Type 2, Class 125, Bronze Globe Valves: Bronze body with PTFE disc and union-ring bonnet. NIBCO T/S 211-Y.

- D. Type 3, Class 300, Bronze Globe Valves: Bronze body with renewable stainless steel seats and union-ring bonnet. NIBCO T-276-AP.

2.12 CAST-IRON GLOBE VALVES

A. Acceptable Manufacturers:

1. Type I, Cast-Iron Globe Valves with Renewable Metal Seats:

- a. NIBCO, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Milwaukee Valve Company.

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with renewable bronze seats. NIBCO F-718-B; F-818-B (Angle).

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with renewable bronze seats. NIBCO F-768-B; F-869-B (Angle Stop/Check/Globe).

2.13 BRONZE, CALIBRATED-ORIFICE, BALANCING VALVES

A. Acceptable Manufacturers:

- 1. Armstrong Pumps, Inc.
- 2. Bell & Gossett Domestic Pump; a division of ITT Industries
- 3. Taco
- 4. Tour-Anderson; available through Victaulic Company

B. Body: Bronze, ball, globe or plug type with adjustable calibrated orifice capable of pre-calculating and pre-setting.

C. Ball: Brass or stainless steel.

D. Plug: Resin.

E. Seat: PTFE or Ametal copper alloy.

F. End Connections: Threaded or solder.

G. Pressure Gage Connections: Integral seals for portable differential pressure meter.

H. Handle Style: Lever, with memory stop to retain set position and marked position settings.

I. CWP Rating: Minimum 125 psig.

J. Maximum Operating Temperature: 250° F.

2.14 CAST-IRON OR STEEL, CALIBRATED-ORIFICE, BALANCING VALVES

- A. Acceptable Manufacturers:
 - 1. Armstrong Pumps, Inc.
 - 2. Bell & Gossett Domestic Pump; a division of ITT Industries
 - 3. Taco
 - 4. Tour & Anderson; available through Victaulic Company
- B. Body: Cast-iron or steel body, ball, plug, or globe pattern with adjustable calibrated orifice venture capable of pre-calculating and pre-setting.
- C. Ball: Brass or stainless steel.
- D. Stem Seals: EPDM O-rings.
- E. Disc: Glass and carbon-filled PTFE.
- F. Seat: PTFE.
- G. End Connections: Flanged or grooved.
- H. Pressure Gage Connections: Integral seals for portable differential pressure meter.
- I. Handle Style: Lever, with memory stop to retain set position and marked position settings.
- J. CWP Rating: Minimum 125 psig.
- K. Maximum Operating Temperature: 250° F.

2.15 NEEDLE VALVES

- A. Acceptable Manufacturers
 - 1. Stockham
 - 2. Nibco
 - 3. Crane
 - 4. Milwaukee
- B. Bronze body and stem, working pressure to match piping system in which installed.

2.16 DIAPHRAGM-OPERATED, PRESSURE-REDUCING VALVES

- A. Acceptable Manufacturers:
 - 1. Amtrol, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Bell & Gossett Domestic Pump; a division of ITT Industries
 - 4. Conbraco Industries, Inc.

5. Taco, Inc.
 6. Spence Engineering Company, Inc.
 7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- B. Design working pressure and temperature suitable for system operating temperature and pressure, 125 psig at 225° F.
- C. Automatic Fill Valves: Pressure regulating type that will not stick nor allow pressure to build up on low side. Capable of field adjustment and set to maintain terminal pressure of approximately 5 psig in excess of static head on system, within a 2-pound maximum variation regardless of initial pressure fluctuation and without objectionable noise under any condition of operation. Brass body with non-corrosive valve seat and stem. Built-in anti-siphon check valve to prevent backflow of water when make-up water line pressure falls below the system pressure.

2.17 DIAPHRAGM-OPERATED, SAFETY VALVES

- A. Acceptable Manufacturers:
1. Amtrol, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett Domestic Pump; a division of ITT Industries
 4. Conbraco Industries, Inc.
 5. Taco, Inc.
 6. Thrush
 7. Spence Engineering Company, Inc.
 8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- B. Design working pressure and temperature suitable for system operating temperature and pressure, 125 psig at 225° F minimum.
- C. ASME label and rated direct spring-loaded type, lever operated, thermostat of stainless steel or protected with a thermo-bonded coating, emergency fusible plug, non-adjustable factory set discharge pressure. Set for temperature and pressure limits of system.
- D. Selection system relief valve capacity so that it is greater than make-up valve capacity and to exceed maximum btu/hr. rating of connected equipment. Use AGA temperature steam ratings when sizing for water heater.

2.18 PRESSURE/TEMPERATURE TEST PLUGS

- A. Acceptable Manufacturers:
1. Peterson Equipment Company, Inc.
 2. SISCO
- B. Solid brass test plug with cap and seal, Nordel inner core for up to 300° F, extension to suit insulation thickness. Test plug capable of receiving either a pressure or temperature probe 1/8-inch O.D. Furnish number of 1/8 inch gauges with adapters and 5 inch stem pocket thermometers for appropriate ranges

specified in Warranty and Contract Closeout article of Part 1 of this section. Provide one Master Test Kit containing a 2-1/2-inch test gauge and two 5 inch pocket thermometers.

2.19 AIR CONTROL DEVICES

A. Acceptable Manufacturers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries
4. Taco.

B. Design working pressure and temperature for all specialties and accessories, suitable for system operating pressure and temperature, 125 psig at 225° F minimum.

C. Air Vent

1. Manual Air Vent: Provide 1/4 inch vent cock.
2. Automatic Air Vent: Float type with isolating valve, brass or cast iron body, copper float, stainless steel valve and valve seat. Suitable for system operating temperature and pressure, minimum 125 sprig. Minimum 3/4 inch inlet for high capacity type, 1/2 inch elsewhere, 1/4 inch outlet.

D. Air Separator

1. Centrifugal type similar to Bell & Gossett "Rolairtrol" Type R, with steel tank, perforated stainless steel air collector and drain connection, ASME stamped for 125 psi working pressure.
2. Size in accordance with manufacturer's recommendations for circulating rate of system, but not less than adjacent pipe size.

2.20 EXPANSION TANK

A. Precharged and pressurized expansion tank, welded carbon steel ASME constructed and stamped for 125 psi, with sealed-in elastomer diaphragm suitable for temperatures to 240° F. Provide air charging fitting, pressure gauge and drain fitting. Provide vertical unit with base for floor mounting.

2.21 STRAINERS GENERAL SERVICE

A. Acceptable Manufacturers

1. NIBCO, Inc.
2. Armstrong Machine Works
3. Hoffman Specialty, ITT
4. Illinois
5. Keckley
6. Mueller Steam Specialty
7. Spirax-Sarco

- B. Cast iron (ASTM A126, Grade B), carbon steel (ASTM A216, Grade WCB) or brass (ASTM B62) body as required to meet system pressure and temperature requirements, screwed or flanged ends matching piping in which installed. Provide straight threaded gasket face cap with gasket for screwed end type, cast iron or hot rolled steel cover with gasket for flanged end type and bottom drain connection. Type 304 stainless steel screen unless otherwise required for application with net free area not less than three times the area of the inlet pipe. Maximum 2 psig pressure drop at design flow.
 - 1. Size 4 inch and under, 1/32-inch (20 mesh) perforated screen.
 - 2. Size 5 inch and larger, 1/8-inch perforated screen.
- C. Y pattern, except basket pattern in low horizontal piping without sufficient clearance for Y pattern screen removal/replacement.
- D. For Stainless Steel Piping: As above except ASTM A296 cast stainless steel body, 150 psig, flanged Y pattern. Mueller Steam Specialty 781-SS.

2.22 FLEXIBLE CONNECTORS

- A. Acceptable Manufacturers:
 - 1. Anaconda
 - 2. Flexonics
 - 3. Korfund
 - 4. Metraflex
- B. General: Fabricate of multiple plies of nylon card, fabric and neoprene, vulcanized so as to become inseparable and homogeneous.
- C. Stainless-Steel Bellow, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 2. End Connections: 2 inches and smaller threaded; 2-1/2 inches and larger flanged.
 - 3. Performance: Capable of 3/4-inch misalignment.
 - 4. CWP Rating: 150 psig.
 - 5. Maximum Operating Temperature: 250° F.
 - 6. Maximum Unit Lengths: 12 inches up to 3-inch size, 18 inches for sizes 4 inches and larger.
- D. Provide control rods or cables to control extension of connector.

2.23 EXPANSION JOINTS

- A. Acceptable Manufacturers:
 - 1. Metraflex Co.
 - 2. Adscos Manufacturing Corp.
 - 3. Flexonics
 - 4. Keflex, Inc.
 - 5. Hyspan Precision Products Co.

B. General

1. Conform to the standards by Expansion Joint Manufacturers Association. Provide joints with design working pressure to match specified class of valves, flanges and fittings of piping system in which installed and with material of construction suitable for piping system in which installed.
2. Provide joint(s) with rated stroke capable of absorbing 200% of maximum piping expansion at installed location.

C. Bellows Type Externally Pressurized Expansion Joint, for all Copper Tubing or Steel Pipe Sizes

1. 150 psig or 300 psig minimum design working pressure to suit character of piping system in which installed, rated piping system expansion up to 8 inches (refer to Paragraph A.2. above) for single joint and 16 inches for dual joint, rated contraction 1/2 inch minimum to 2 inches for single joint, forged steel flanged ends.
2. Packless all welded construction, inner pipe and housing ASTM A53 Grade B of equal or greater schedule than piping system in which installed, internal guide ring with travel limited to rated expansion stroke plus 1/2 inch maximum, laminated or multiply stainless-steel bellows, housing drain and vent ports.
3. Factory or field installed reducer for pipe sizes smaller than 2 inches.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings, with Press System (press to connect) joints.

B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings, with Press System (press to connect) joints, up to 4 inches.
3. Type L, drawn-temper copper tubing, wrought-copper fittings up to NPS 3. Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Solder mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.
4. Schedule 40 steel pipe, except 0.375-inch wall for sizes 12 inches and larger. Wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings and welded and flanged joints. Nipples Schedule 80.
5. Schedule 40 steel pipe, except 0.375-inch wall for sizes 12 inches and larger. Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.

- C. Condensate-Drain Piping, NPS 1 and smaller shall be any of the following:
 - 1. Type L, drawn temper copper tubing, wrought copper fittings, and soldered joints.
 - 2. Type L, drawn-temper copper tubing, wrought-copper fittings, with Press System (press to connect) joints.
- D. Condensate-Drain Piping NPS 1-1/4 and larger, shall be the following:
 - 1. Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- E. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 PIPING INSTALLATION

- A. Refer to Section 23 05 00, "Common Materials and Methods for HVAC", for general piping installation requirements.
- B. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- D. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe. Bull head tees are not allowed.
- E. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 VALVE APPLICATIONS

- A. Unless otherwise noted, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling or Balancing Service: Angle, ball, butterfly, or globe valves. Butterfly valves not allowed for balancing at pump discharge or for cooling tower balancing service.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves (non-slam)
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

- C. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- D. Install calibrated-orifice, balancing valves at each branch connection to return main.
- E. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- F. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- G. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.
- H. Safety relief valve vent lines shall not connect to piping serving other relief devices or equipment.
- I. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- J. Chilled-Water Piping: Use the following types of valves:
 - 1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
 - 2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
 - 3. Ball Valves, NPS 2 and Smaller: Two piece, 600-psig CWP rating, copper alloy.
 - 4. High-Pressure (High Performance) Butterfly Valves, NPS 2-1/2 and Larger: Threaded Lug Type, Class 300.
 - 5. Lift Check Valves, NPS 2 and Smaller: Type 1, Class 125, horizontal or vertical, bronze.
 - 6. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
 - 7. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
 - 8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
 - 9. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 125, cast iron.
 - 10. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
 - 11. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze- mounted cast iron.

3.4 VALVE INSTALLATION

A. General

- 1. Provide valves at locations shown, where specified and where required to properly control piping systems. Provide valves recommended or required by equipment manufacturers and codes for proper operation of equipment and shutoff valves to allow isolation of each main and branch service line, whether or not indicated or specified.
- 2. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- 3. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- 4. Examine threads on valve and mating pipe for form and cleanliness.
- 5. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

6. Do not attempt to repair defective valves; replace with new valves.
 7. Install valves in horizontal piping with stem at or above the center of the pipe.
 8. Install valves in a position to allow full stem movement.
- B. Check Valves: Provide lift check type after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.
- C. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.

3.5 HYDRONIC SPECIALTIES INSTALLATION

A. Expansion Tank

1. Provide expansion tank for the following systems:

- a. Chilled Water

B. Pressure/Temperature Test Plugs: Provide nipple as required to locate cap of P/T plug outside of surface of pipe insulation.

C. Relief Valves

1. Provide as required or shown on all water systems and equipment. Aggregate relieving capacity as required by ASME Code.
2. Select system relief valve capacity so that it is greater than makeup pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
3. Pipe relief valve outlet to nearest floor drain.
4. Safety relief valve vent lines shall not connect to piping serving other relief devices or equipment.

3.6 COOLING COIL CONDENSATE DRAIN PIPING

- A. Comply with requirements of applicable mechanical and plumbing code.
- B. Drain piping for air conditioning units may not be shown on the Drawings. Provide as required, whether or not indicated.
- C. Provide drain piping for room air conditioning units.
- D. Provide water seal traps of sufficient depth to maintain water seal against system static pressure. Enter building drainage system only through an air gap. Run piping to nearest convenient floor drain or as indicated. Pitch at least 1/4 inch per foot unless otherwise noted or directed.

- E. Provide plugged "TY" at each change in direction and at approximately 60-foot centers on straight runs. Provide cleanout at base of vertical risers as required.

3.7 FLEXIBLE PIPING CONNECTIONS

- A. Install where shown, where specified and at all base-mounted pumps, chillers, and elsewhere where required. On pipes connected to equipment supported by vibration isolation, install parallel to axis of rotation. Install one end immediately adjacent to the isolated equipment and anchor other end.
- B. Flexible piping connections shall not be used to correct misalignment between equipment and connected piping.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)
- C. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure for a minimum of 4 hours with no drop in pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of

specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. At the beginning of the pressure test, and periodically during the test, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

D. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.
- B. Related Sections
 - 1. Division 23, "Common Materials and Methods for HVAC"
 - 2. Division 23, "Vibration Isolation and Seismic Restraints for HVAC Systems"
 - 3. Division 23, "Unitary Air Conditioning"

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-32:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig
 - 2. Suction Lines for Heat-Pump Applications: 535 psig
 - 3. Hot-Gas and Liquid Lines: 535 psig

1.4 SUBMITTALS

- A. Product Data: Include catalog cuts for factory fabricated items.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 MANUFACTURER'S SUPERVISION/INSPECTION SERVICE

- A. Refrigerant Piping System: Provide the services of the equipment manufacturer, or his authorized representative, to design and supervise the installation, cleaning and testing of the field installed refrigerant piping system. At the completion of the installation, the equipment manufacturer shall certify, in writing, to the Architect that the installation was made in accordance with his design and

recommendations and shall provide record fabrication drawing schematics showing all pipe sizes and specialties of complete refrigerant piping systems.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube for Refrigerant Service: ASTM B 280, ACR copper tubing, Type K or L Hard, except soft tubing in coils may be used in sizes 7/8 ODS and smaller for final branch to equipment having flared connections. Pipe and fittings manufactured especially for refrigeration. All pipe cleaned, dried, charged with nitrogen and sealed with pressure tight plugs at the factory.
- B. Copper Tube for Refrigerant Vent Service: ASTM B 88, Type L Hard copper tubing.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Cast Brass Fittings: ANSI B16.18, Tinned coat brass may be used in larger sizes where wrought copper is not available.
- F. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- G. Brazing Filler Metals: AWS A5.8.
- H. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.

4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Grade B black steel with plain ends; Schedule 40, nipples Schedule 80, coated with ASTM B6 slab zinc inside and outside by the hot-dip process.
- B. Malleable Iron Threaded Fittings: ASTM A 197 black malleable iron. ANSI B16.3, Class 150 banded, with ANSI B1.20.1 standard taper pipe threads. Coated with ASTM B6 slab zinc inside and outside by the hot-dip process.
- C. Flexible Connectors:
 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
 2. End Connections:
 - a. NPS 2 and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 and Larger: With flanged-end connections.
 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 4. Pressure Rating: Factory test at minimum 500 psig.
 5. Maximum Operating Temperature: 250 deg F.

2.3 REFRIGERANT VALVES AND SPECIALTIES

- A. Acceptable Manufacturers:
 1. Henry Valve Co.
 2. Sporlan Valve Co.
 3. Superior Valve Co.
 4. Mueller Brass Co.
- B. Type REFV, Refrigerant Valves
 1. Shutoff Valves: Brass, back seating ball, globe, and angle valves. Diaphragm packless type for 1-5/8-inch ODS and smaller, packed type with winged sealing cap for 2-1/8 inch ODS and larger.
 2. Check Valves: Brass body and piston, stainless steel spring, screw cap for 5/8-inch ODS and smaller. Bronze body, floating piston, soft seat disc for 7/8-inch ODS and larger.

2.4 REFRIGERANT STRAINERS

- A. Acceptable Manufacturers:
 1. Henry Valve Co.

2. Sporlan Valve Co.
3. Superior Valve Co.
4. Mueller Brass Co.

- B. Angle or Y pattern, brass body, renewable screen of 100 mesh monel metal reinforced with 10 mesh brass screen, not screen free area at least 10 times that of refrigerant line.

2.5 REFRIGERANTS

- A. ASHRAE 34, R-32: Difluoromethane.

PART 3 - EXECUTION

3.1 REFRIGERANT PIPING APPLICATIONS

- A. Suction Lines for Conventional Air-Conditioning Applications: ACR Copper, Type K or L, hard tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: ACR Copper, Type K or L, hard tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping NPS 2-1/2 and Larger: Schedule 40, galvanized steel pipe and galvanized fittings with threaded joints.
- D. Safety-Relief-Valve Discharge Piping NPS 2 and Smaller: Copper, Type L, drawn- temper tubing and wrought-copper fittings with soldered joints.

3.2 REFRIGERANT PIPING AND SYSTEM INSTALLATION

- A. Refer to Section 23 05 00 "Common Materials and Methods for HVAC", for general piping installation requirements.
- B. Install refrigerant piping according to ASHRAE 15, complete with hangers, fittings, valves, strainers, drier, oil traps, etc.
- C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- D. Install refrigerant piping in protective conduit where installed belowground.
- E. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- F. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 2. Install horizontal suction lines with a uniform slope downward to compressor.
 3. Liquid lines may be installed level.

- G. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- H. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- I. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- J. Bleed dry nitrogen through the lines when making joints.
- K. Size and run refrigerant piping in accordance with common good practices, the recommendations of the equipment manufacturers and the Equipment Standards of the Air Conditioning and Refrigerating Machinery Association, Inc. Entire installation, including safety devices, testing and cleaning, conform to ANSI B9.1 and B31.5. Provide piping system, as required, with: liquid-suction heat exchangers, ASME coded liquid receivers, double risers, all necessary purge and charging valves and moisture indicating liquid line sight glass in each circuit, shutoff, relief and drain valves and connections, a full-flow removable cartridge type refrigerant drier and a strainer installed with a three valve bypass arrangement in the liquid line close to each condensing unit if not built into the equipment, a strainer in the suction connection to each compressor if the compressor does not have built-in scale traps, external strainers on the inlet side of each solenoid valve and each thermal expansion valve, regardless of any internal strainer that may be incorporated in the valve construction, hot gas muffler, and flexible connections at equipment mounted on resilient supports.
- L. Provide appropriate refrigerant charging and recovery valves and fittings in each refrigerant circuit.
- M. Provide pressure relief valves if required for venting. Pipe relief lines to outside of building, terminate with an ell turned down and a bug screen.
- N. Isolation valves shall be low pressure drop design ball type, designed specifically for refrigerant system.
- O. Provide necessary operating charges of refrigerant and oil.
- P. Clean interior of any refrigerant piping, should it become dirty, by first rodding pipe with a wire brush and then rodding pipe with cheesecloth with refrigerant oil on it. Make at least three (3) passes with cheesecloth using a clean cheesecloth with clean refrigerant oil each time.
- Q. Test as specified hereinafter under FIELD QUALITY CONTROL, and charge with refrigerant. If initial charging occurs at ambient temperature below 55 degrees F., recharge again when ambient is above 55 degrees F. Test and recharge with refrigerant as required during first full summer of operation, April 1, through October 31, without additional cost to Owner.
- R. Support piping at no more than eight-foot intervals and pitch not less than 1 inch per 20 feet in direction of flow.
- S. Provide the services of the equipment manufacturer, or his authorized representative, as specified in the Article titled "Manufacturer's Supervision/Inspection Services".

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with dry nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test (minimum 24 hours).
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.4 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.5 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 30 00 – DUCTWORK AND DUCTWORK 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. This Section includes the following:
 - 1. Sheet metal ductwork and fittings
 - 2. Sheet metal casings and plenums
 - 3. Duct Accessories; including dampers, flexible connectors, flexible duct, access doors
 - 4. Air volume control boxes
 - 5. Diffusers, registers and grilles
- B. Related Sections include the following:
 - 1. Duct mounted smoke detectors are specified in Division 28
 - 2. Airflow measuring stations are specified in Division 25
 - 3. Motorized control dampers are specified in Division 25

1.3 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For acoustically lined ducts and casings, maintain sizes inside lining. For rectangular ductwork in plan, first dimension indicates width, and second dimension indicates height.
- B. Pressure Class: The numerical duct construction pressure classification that identifies permissible SMACNA Duct Construction Standards.
- C. Seal Class: Identifies the extent of sealing of duct joints, seams and penetrations per SMACNA Duct Construction Standards.
- D. Leakage Class: Identifies permissible leakage as described in SMACNA HVAC Air Duct Leakage Test Manual.
- E. Low Pressure Ductwork: 3 inch wg and less.
- F. Medium Pressure Ductwork: 4 inch wg and 6 inch wg.
- G. High Pressure Ductwork: Greater than 6 inch wg.

1.4 REFERENCES

- A. SMACNA: HVAC Duct Construction Standards – Metal and Flexible
- B. SMACNA: HVAC Air Duct Leakage Manual
- C. ARI 880: Air Volume Terminals
- D. UL: Applicable Standards

1.5 SUBMITTALS

- A. Product Data:
 - 1. Provide booklet of Shop Standards, including the following:
 - a. Duct construction classification and fabrication, assembly, and installation details including SMACNA Tables and Figure numbers clearly marked to identify which are to be used.
 - b. Details of shop fabricated items, fittings, reinforcing details and spacing, seam and joint construction.
 - c. Installation details of duct mounted equipment and accessories, including dampers, coils, access doors, hangers and supports.
 - d. Product data for factory fabricated equipment, dampers, access doors, flexible duct, etc.
 - 2. For each type of product indicated, include performance characteristics, rated capacities, data sheets, and furnished accessories.
 - 3. Shop Standards shall be submitted for review prior to submission of sheet metal shop drawings. Any sheet metal shop drawings submitted prior to the shop standard review will be returned as “Rejected”.
- B. Product Schedule or Lists: Include Diffuser, Register and Grille Schedule, indicating Drawing designation, room location, quantity, model number, size and accessories furnished.
- C. Shop Drawings: Prepare CAD-generated shop fabrication drawings to a scale of not less than 3/8 inch per foot. Show complete ductwork and casing layout, including:
 - 1. Duct layout indicating sizes and pressure classes.
 - 2. Elevations of top and bottom of ducts.
 - 3. Dimensions of main duct runs from building grid lines.
 - 4. Fittings.
 - 5. Clearly show all duct accessories, including access doors, dampers, diffusers, and grilles.
 - 6. Acoustical lining and thickness as applicable.
 - 7. Prepare duct layout based on routing indicated on the drawings and make reasonable modifications to layout without increasing duct system pressure drop in order to coordinate with other trades. Refer to “Layout and Coordination with other Trades” specified in Section 23 05 00. Do not submit duct shop drawings until multi-discipline coordination drawings specific in Division 1 are completed.

8. Clearly identify by circle and by note "Deviation" and/or "Interference" in large lettering any and all deviations from Drawings and any and all unresolved interference conditions and assume full responsibility for failure to do so.
9. Submit all shop drawings for review.
10. Modify shop fabrication drawings in accordance with Architect's review comments, if any, and to show any subsequent shop or field changes. At completion of work, submit final shop fabrication drawings labeled "As-Built" to the Owner for record purposes.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.7 COORDINATION

- A. Coordinate location of duct access doors to allow proper access to dampers, coils, fans, etc. Coordinate with General Contractor proper location of wall and ceiling access panels to permit access to duct access doors.
- B. Coordinate location of duct mounted equipment (coils, humidifiers, filters, smoke detectors) furnished in other Sections for installation under this Section. Provide duct transitions as required.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; zinc coating each side, complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill- phosphatized finish for surfaces exposed to view.
- C. Aluminum Sheets: ASTM B209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Reinforcements: Structural shapes (channels, angles, and plates) shall be of galvanized steel where installed on galvanized ducts, and Type 304 stainless steel where installed on stainless steel ducts.

2.2 SEALANT MATERIALS

A. Acceptable Manufacturers:

1. United McGill Corp.
2. H.B. Fuller Co., Foster Products Division
3. Precision Adhesives
4. Carlisle Hardcast
5. General Electric Co.

B. General:

1. The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
2. Sealants for air distribution systems shall be of liquid and/or mastic type in accordance with SMACNA.

C. All sealants shall be UL Classified and meet NFPA 90A, Class 1 requirements when applied in a manner consistent with its intended use. Ratings shall not exceed a Flame Spread of 25 or a Smoke Developed of 50. All containers and shipping cartons shall bear the UL label indicating flame and smoke ratings and shall include Fire Hazard Classification. Labeling shall also include Hazard Statement required by the Consumers Product Safety Act, CFR Title 16, Chapter II, subchapter C, Federal Hazardous Substances Act Regulations, Part 1500, Section 1-272.

D. Sealants for air distribution systems shall be compatible with the materials, application and operating temperatures of the system. Sealants used for systems handling fumes and chemicals shall be confirmed suitable for the specific application. Sealants exposed to the weather, shall be ultraviolet light and ozone resistant and provide watertight seal.

E. Sealants shall be applied in accordance with manufacturer's instructions. Provide adequate ventilation and follow safety procedures as required. Adequate drying/curing time shall be allowed before operating or testing the systems.

F. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

G. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

H. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

I. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.3 DUCT PRESSURE CLASSIFICATION AND CONSTRUCTION

A. Construct ducts for pressure class indicated (positive or negative), and seal all seams and joints to achieve Seal Class A, Leakage Class 6 for rectangular duct and Class 3 for round duct, according to the following:

1. Supply Ducts between AHU and Air Volume Control Box: 4-inch wg positive.
 2. Supply Ducts between Air Volume Control Box and Diffuser: 2-inch wg positive.
 3. Supply Duct Systems without Air Volume Control Boxes: 2-inch wg positive.
 4. Outside Air Ducts: 2-inch wg negative.
 5. Return Ducts between AHU and Air Volume Control Box: 3-inch wg negative.
 6. Return Ducts between Register or Grille and Air Volume Control Box: 2-inch wg negative.
 7. Return Duct System without Air Volume Control Boxes up to AHU: 2-inch wg negative.
 8. General Exhaust Duct System without Air Volume Control Boxes: 2-inch wg negative.
- B. Material: All ducts shall be galvanized steel, except where specifically noted otherwise on drawings and as follows:
1. Shower Exhaust Ducts: Aluminum.

2.4 GENERAL DUCT FABRICATION

- A. Detail and fabricate with the fewest possible joints in accordance with SMACNA standards and details, except where more stringent requirements are specified in this section, to keep resistance losses to a minimum.
- B. Size round ducts installed in place of rectangular ducts, and vice versa, from ASHRAE table of equivalent rectangular and round ducts. Aspect ratio of rectangular ducts can be modified for coordination of layout, but in no case exceed 4 to 1, and without reducing free area of duct or increasing pressure drop.
- C. Complete metal ducts within themselves with no single partition between ducts. Open corners are not acceptable.
- D. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- E. Sleeves:
1. Construct sleeves of galvanized steel minimum 22 gauge unless noted otherwise.
 2. Provide sleeves for fire dampers and combination fire/smoke dampers as specified in this Section "Fire and Smoke Dampers".
 3. Breakaway connections are not permitted except for pressure class 2-inch wg and less.
- F. Square heel and throat elbows, with vanes, are used on Drawings for drafting convenience only. Where space allows, construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible on rectangular ductwork, provide smooth radius elbows with full length splitter vanes designed and constructed in accordance with SMACNA Duct Design and Duct Construction Standard to produce a loss coefficient of 0.15 or less, except as follows:
1. Where R/W is such that a vaned radius elbow will not produce the specified loss coefficient and on exposed ductwork in finished areas, provide mitered elbows with square heel and throat and with double thickness turning vanes set into vane runners with a radius of 4-1/2 inches on 3-1/4 inch centers, designed and constructed to produce a loss coefficient of 0.26 or less in accordance with above standards.

2. Increase/decrease duct sizes gradually, not exceeding 15° divergence/ convergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

G. Unless otherwise indicated or specified, fabricate branch connections as follows:

1. Rectangular duct branch connection to rectangular ductwork, 45° SMACNA entry/exit butt flange boot with corner filler pieces or proportional splits at Contractor's option. Where size of main duct is not large enough for a boot connection, fabricate ducts with proportional splits.
2. Round duct branch connections to round ductwork, conical tee.
3. Round branch connection to rectangular ductwork, bellmouth connection equal to Buckley BM or BMD or high efficiency boot connection equal to Buckley 3300 or 3300D.
4. Where round duct is connected to rectangular duct and rectangular duct width shown is not equal to or larger than overall diameter of connecting end of round connector BENDING OF FLANGES OF ROUND CONNECTOR FOR CONNECTION TO RECTANGULAR DUCT IS NOT ALLOWED. Either increase rectangular duct width as required or provide a rectangular 45° SMACNA boot connection to the rectangular duct and a rectangular to round conversion for the round duct connection. For round connection to low pressure ductwork. Contractor may, at his option use a mini bellmouth connection equal to Buckley M-BM or M-BMD or a flat oval bellmouth equal to Buckley FOBM or FOBMD and an oval to round conversion for the round duct connection.
5. Spin-in, cinch lock or dovetail fittings not allowed except at duct connection to a transfer duct.
6. Connect branch to top, bottom or side of duct as indicated or as required, whether or not indicated, to suit surrounding conditions and avoid interferences.
7. Coordinate branch take-off locations with transverse joint spacing. Transverse joints interfering with branch take-offs will not be accepted. Modify joint spacing as required without exceeding maximum spacing.

H. Rigidly construct ducts with joints mechanically tight, substantially airtight without use of tape, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Where joints are not accessible for sealing, provide access doors and seal from inside.

I. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10% duct area, split into two ducts maintaining original duct area. No easements or penetrations allowed for medium or high-pressure ductwork.

J. Fabricate goosenecks of aluminum equivalent to not less than 18-gauge galvanized steel. Rigidly reinforce and brace. Provide hinged 1/2-inch mesh aluminum hardware cloth bird screen. Fabricate for lowest edge of opening not less than 24 inches above finished surface of roof for exhaust, and 36 inches above roof for intakes.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Construct ducts of minimum 24 gauge.

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2. Do not install tie-rods in areas where system effects apply including upstream and downstream of fans and sound attenuators or within three times the published absorption distance of humidifiers.
 3. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 4. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Flat Drive Joints: Flat drive joint constructed of not less than 24 gauge and specified static pressure in accordance with the limits of SMACNA will be accepted as Class A reinforcement for low pressure (2 inches w.g. and less) ductwork located in shafts or furred spaces that do not have adequate clearance for factory fabricated or formed flanged joints.
- C. Transverse Joints: Prefabricated slide-on joints with four bolted flange, fastened to duct section with spot welds (do not use screws), and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement. Ductmate Industries, Inc., Nexus Inc., Ward Industries, Inc.
- D. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details. Ductmate Industries, Inc. TDC or Lockformer.
1. Use joint reinforcing for T-24 or T-25 joints and sheet metal gauges as recommended by SMACNA Standards as a minimum. Do not use lighter gauges shown in joint manufacturer's literature.
- E. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant. Button punch snaplocks and pocket locks are not permitted.
- F. Cross Breaking or Cross Beading: For duct pressure class 3 inch or less, cross break or cross bead duct sides 18 inches and larger and 20 gauge thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.6 ROUND DUCT AND FITTING FABRICATION

- A. Acceptable Manufacturer: Factory fabricated, or shop fabricated but equal in all respects to factory fabricated items specified herein:
1. McGill AirFlow Corporation.
 2. SEMCO Incorporated.
- B. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- C. Round Duct and Fittings: Lock type spiral seam construction of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible Stamped elbows and fittings. Gored (segmented) elbows and fitting only for sizes where stamped elbows and fittings not available. Adjustable elbows are not permitted.

- D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- F. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- G. Plastic coated where specified.

2.7 FLEXIBLE DUCTWORK

- A. Acceptable Manufacturers: Type numbers indicated are those of Thermaflex.
 - 1. Thermaflex
 - 2. Flexmaster, Inc.
- B. UL listed under UL-181 as Class 1 Air Duct Connector and conforming to NFPA 90A and 90B.
- C. Minimum Rating: 10-inch WG positive all uses, 2 inch WG negative for return or exhaust use, velocity of 4000 feet per minute.
- D. Type "M-KC". Continuous galvanized spring wire helix having a cover of woven fiberglass fabric, vinyl impregnated and coated, or continuous corrugated aluminum for low pressure supply use only and insulated with 1-inch-thick fibrous glass insulation having outer moisture barrier consisting of reinforced metalized Mylar/ neoprene laminate with integral attaching devices. "U" factor at 75° F differential maximum 0.22 btu/sq.ft./° F/hour.
- E. Attachment: Duct clamp stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action in size to suit duct size.

2.8 HANGERS AND SUPPORTS

- A. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible" for steel sheet width and thickness and for steel rod diameters. Perforated strap hangers are not allowed.
 - 2. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Hanger fasteners shall not pierce medium/high pressure (greater than 3 inches w.g.) ductwork under any circumstance.
- C. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.9 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or stainless steel, or 0.032-inch-thick aluminum sheets. Select metal compatible with connected duct system. Comply with SMACNA requirements.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 SHOP AND FIELD FABRICATED CASINGS

A. Fabricate casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", except where more stringent requirements are specified herein.

B. Shop fabricate casings, to greatest extent possible, with a minimum number of joints and to minimize field fabrication and assembly.

C. Fabricate casings with standing seams and angle reinforcements. Reinforce casings with galvanized- or painted-steel angles. Seal joints with liquid-type, high-pressure duct sealant to eliminate air leakage.

D. Fabricate casings with reinforced and braced openings for hinged access doors at least 24 inches wide by 48 inches high and located for access to each item of equipment housed, or where shown on drawings for cleaning and inspection. Provide double wall access door when installed in insulated plenums.

E. Provide minimum 3-inch-high reinforced concrete curb for floor mounted walls. At floor, rivet panels on 8-inch centers to steel angles.

2.11 FACTORY FABRICATED CASINGS

- A. Acceptable Manufacturers:
1. Industrial Acoustics Company
 2. Vibro-Acoustics, Co.
 3. McGill Airflow Corporation
 4. SEMCO Incorporated
- B. Double-wall, insulated, pressurized equipment casing.
- C. Panel Fabrication: Solid, galvanized sheet steel exterior shell and solid, galvanized sheet steel interior shell; with 2- or 4-inch space between shells, as indicated.
1. Fabricate with a minimum number of joints.
 2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
 3. Exterior Shell Thickness: 0.040 inch minimum.
 4. Interior Shell Thickness: 0.034 inch minimum.
 5. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.
 6. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant, and vermin proof, and that complies with NFPA 90A.
 7. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.
- D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.
- E. Access Doors: Fabricate personnel access doors at least 24 by 60 inches and other access doors in sizes indicated.
1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch solid, interior and exterior, galvanized sheet steel shell.
 2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.
 3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
- F. Structural Performance: Fabricate plenum to be self-supporting and capable of withstanding internal static pressures as scheduled, without any panel joint exceeding deflection of $L/200$ where "L" is the unsupported span length within completed casings.
- G. Acoustic Performance: Certified by an independent acoustical testing agency listing sound- absorption and transmission-loss characteristics of panel assemblies.
- H. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

2.12 VOLUME DAMPERS

- A. General: Factory fabricated, or shop fabricated but equal in all aspects to factory fabricated items, with required hardware and accessories in accordance with SMACNA duct standards except as noted herein.
- B. Damper and damper frames shall be constructed of same material as duct in which they are installed. Fabricate single blade damper of minimum 20 gauge. Fabricate multi-blade damper of minimum 16 gauge.
- C. Damper blades in rectangular ductwork shall be maximum 8 inches wide. Dampers having two or more blades shall be opposed action type with connecting bar and linkage. Multiple blade dampers shall be mounted in frames. Splitter dampers not allowed.
- D. Provide for multiple section damper (larger sizes), appropriately sized jackshaft with bearing assemblies mounted on supports at each mullion and at each end of the multiple damper section. Provide appropriate length and number of mountings to connect linkage of each damper to the jackshaft.
- E. Stiffen blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Device shall include indication of damper position. Provide end bearings and gaskets for damper components to seal duct consistent with pressure class.
- F. Damper Hardware: Dampers shall be provided with all hardware including zinc plated, die-cast core with dial and handle made of 3/32-inch-thick zinc plated steel, and a 3/4 inch hexagon locking nut. Include center hole to suit damper operating rod size. Include raised quadrant for mounting on insulated duct. Improvised shop or field fabricated hardware will not be accepted.

2.13 REMOTE CEILING DAMPER REGULATOR

- A. Acceptable Manufacturers
 - 1. Young Regulator
- B. System specifically designed for remote manual adjustment of duct mounted volume damper.
- C. Damper controller and cable shall be concealed above the ceiling and wall. Cable to consist of Bowden cable 0.054-inch stainless steel control wire encapsulated in 1/16-inch flexible galvanized spiral wire sheath. Maximum 50 feet length of cable distance between damper and control kit.
- D. Damper:
 - 1. Round damper constructed of heavy-duty galvanized steel spiral shell design with rolled in stiffening beads for rigidity. Spiral shell shall have one crimped end and one straight end for ease of installation. Damper to include "V" style 20-gauge galvanized steel blade secured with 1/2 inch diameter steel shaft and Teflon bushings. Young Regulator Model 5020-CC.
 - 2. Rectangular damper to be opposed blade type constructed of heavy duty extruded aluminum frame and blades. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched stainless

steel connecting slide rails that facilitate blade movement and alignment. Young Regulator Model 830A-CC.

3. Damper shall include all necessary hardware to ensure compatibility with Bowden remote cable control system.
- E. Control Shaft: Shall be D-styled flatted ¼ inch diameter with 265-degree rotation providing graduations for positive locking and control, and 1 ½ inch linear travel capability.
- F. Control Kit: Shall be designed for use with internally or externally controlled round or rectangular dampers and shall consist of 14-gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit mounting bracket can be field mounted on ceiling framework, behind grilles, on or inside plenum slot diffusers, or on diffuser back pan. Include wrench for damper adjustment. Young Regulator Model 270- 275.

2.14 BACKDRAFT DAMPERS

A. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Air Balance, Inc
4. American Warming and Ventilating Co.

B. Low Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action gravity balanced backdraft damper with minimum .050-inch aluminum blades a maximum of 6-inch width having flexible vinyl sealing edges, linked together in rattle-free manner and with adjustment device to permit setting for varying differential static pressure. Blade pivot pins mounted in nylon bearings in a minimum 0.050 inch extruded aluminum mounting frame. Constructed for up to 1500 feet per minute face velocity and 1/2-inch water gauge static pressure. Suitable for horizontal or vertical applications as indicated.
2. Provide minimum 0.050 inch extruded aluminum wall frame with mounting flange for wall mounted damper.

C. High Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action, gravity balanced backdraft damper with airfoil blades a maximum of 6-inch width having flexible vinyl sealing edges and neoprene jamb seals.
2. Pressure drop for a 24 inch x 24 inch damper shall not exceed 0.2 inch water gauge when tested in accordance with AMCA Standard 500, Figure 5.3 with ductwork upstream and downstream of damper.
3. Blades interconnected with on-blade linkage. Provide external counterbalance on extended shaft, field adjustable for system flow and pressure.
4. Minimum 14-gauge, galvanized steel, 8 inch by 2 inch formed channel frame with minimum 18 gauge galvanized blades mounted on minimum 3/4 inch zinc plated shafts rotating in 3/4 inch bore ball bearings. Designed for up to 4,500 feet per minute face velocity and 7 inches water gauge static pressure for Class 2 fans.

2.15 ACCESS DOORS

- A. General: Factory fabricated double wall access doors in accordance with SMACNA standards except as specified herein. Improvised shop or field fabricated access doors will not be permitted.
- B. Fabricate doors airtight and suitable for duct pressure class. Access doors shall be double wall constructed of the same material as the ductwork in which they are installed except that doors located in ducts constructed of plastic, FRP and PVC coated steel shall be constructed of Type 304 stainless steel.
- C. Rectangular Duct: Provide door with closed cell full sealing gaskets and quick turn fastening locking device. Provide hinged doors with butt or piano hinge and 2 cam latches. For medium and high-pressure duct, hingeless with minimum 4 cam latches and factory installed retaining cable.
- D. Round Duct: Provide double wall insulated and gasketed door with minimum 2 compression latches.
- E. For insulated ductwork, fabricate double wall with insulation fill and thickness not less than adjacent duct insulation. Provide raised hinge type.
- F. Access door size 16 inches by 20 inches unless otherwise indicated. Where size of duct will not accommodate this size, provide size as large as possible, minimum 12 inch by 6 inch. Provide view window where indicated.

2.16 INSTRUMENT TEST HOLES

- A. Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness. Ventlock 699 by Ventfabrics or approved equal.

2.17 DUCT ROOF CURBS

- A. Welded galvanized steel, insulated mounting curb without cant strip and with treated wood nailer suitable for duct roof penetration. Fibrous glass insulation minimum 1 ½ inch thick. Curb height as required for top of curb not less than 12 inches above finished roof surface. As manufactured by ThyCurb, Pate, Penn Ventilator, or equal.
- B. Furnish roof curb to Division 07 for installation.

2.18 AIR VOLUME CONTROL BOXES

- A. Acceptable Manufacturers:
 - 1. Price Industries
 - 2. Anemostat
 - 3. Tuttle & Bailey
 - 4. Titus
 - 5. Nailor Industries

B. General:

1. Factory fabricated assembly consisting of casing, damper, airflow sensor and other accessories as specified herein.
2. The assembly operation shall be pressure independent and shall reset to any airflow throughout entire operating range.
3. Performance ratings shall be certified in accordance with ARI 880 and shall bear the ARI seal. Sound ratings calculated in accordance with ARI 885.
4. Identification: Provide label on each box indicating identification number shown on drawings, maximum and minimum airflow range, scheduled airflow and calibration curve.
5. Units listed and labeled as defined in NFPA 70 by a testing agency applicable to authorities having jurisdiction and marked for intended use.

C. Configuration:

1. Boxes shall be suitable for electric powered pressure independent air volume control system and temperature control system furnished by Division 25. Boxes shall include airflow sensor and damper with extended shaft compatible with unit mounted controller.
2. Provide integral power transformer 120/24 volt of each air volume control box.

D. Casing:

1. Minimum 22-gauge galvanized steel housing. Inlet collar minimum 2-inch depth for securing duct connection. Outlet slip and drive connection.
2. Provide insulated double wall access door or removable panel for access to all interior components and coil cleaning.
3. Provide sheet metal frame in box casing and gasket seal to obtain specified maximum leakage.
4. Standard casing: Construct and seal casing and access panel for leakage not to exceed 2% of unit rated airflow, or 10 CFM, whichever is greater, at 1.5-inch wg static pressure.

E. Insulation:

1. Fibrous glass: 1/2-inch-thick 1½ pound density fibrous glass insulation, coated with a durable fire and damage resistant surface to prevent erosion complying with ASTM C 1071; secured with adhesive. All exposed edges shall be coated.
2. Polymer foam: ¾ inch thick closed cell polymer foam, complying with UL 181 erosion requirements, and having maximum flame spread index of 25 and maximum smoke developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
3. The unit insulation shall be fully enclosed with non-porous foil liner. All edges sealed within metal nosing or with NFPA 90A approved sealant.

F. Damper:

1. Damper constructed of two heavy gauge metal plates sandwiched around gasketed blade seal with solid one piece aluminum shaft rotating in self-lubricated bearings extended outside of unit casing. Construct of materials that cannot corrode and do not require periodic servicing. Hollow metal shaft is not permitted.
2. Provide damper blade seals and shaft bearing bushings to satisfy required leakage. Damper shaft shall include an integral marker at the end of shaft to indicate damper position.
3. Damper leakage for closed damper shall not exceed 2% of the nominal catalog rating at 3-inch wg inlet pressure. ARI 880 rated.

G. Air Flow Sensor:

1. Center tapped cross flow, center-averaging sensor located in inlet collar, constructed of plastic meeting UL fire resistance, reinforced to prevent damage.
2. Sensor shall amplify pressure signal by a factor of not less than 1.7 and shall maintain control accuracy within plus or minus 5% throughout operating range with the same size inlet duct in any configuration. Sensor shall not require any minimum length of straight duct to maintain control accuracy.
3. Sensor shall have a minimum of 3 static pressure and 4 total pressure measurement points on all inlet sizes. Pressure sensing tubes shall be extended to the outside of casing for connection to the airflow controller. Tubing secured to casing with grommets.
4. Sensor shall be aerodynamically designed with negligible pressure drop or noise contribution.

H. Electric Heating Coil:

1. Factory mounted, slip in type, open coil design, factory wired and installed in 20-gauge galvanized steel casing. Nickel chrome 80/20 heating elements.
2. Equip with both primary and secondary over temperature protection meeting UL and NEC requirements. Provide integral control box with integral contactors of deenergizing or disconnecting type. Proof of airflow, either by airflow switch or motor current meter, shall be wired into coil safety circuit to prevent energizing of coil when airflow is not present.
3. Coil UL listed as suitable for installation as duct heater with zero clearance to combustible surfaces. Steps of control as indicated minimum of two steps for coils larger than 5 kw.
4. Provide access door or removable panel for access upstream of coil. Heater controls shall be accessible from the same side as the primary air controls. Provide noninterlocking disconnect switch.

I. Control Package:

1. Provide factory mounted electric damper motor for air volume control and velocity reset controls for pressure independent operation throughout entire operating range.
2. Include all required accessories and box controls to accomplish sequence of operation specified in Division 25.
3. Submittals shall clearly indicate accessories, normal damper position (open or closed), etc. for sequences specified, in plain English, without the need for interpretation of manufacturer's part number or model number to determine what is being provided.
4. Box manufacturer shall be fully responsible for coordinating and verifying compatibility of air volume control box with sequences specified in Division 25.
5. Coordinate for direct attachment of damper actuator to shaft. Additional linkages, swivels, or levels are not acceptable.
6. Electric Controls: Provide electrically operated pressure independent air volume control and temperature control system.
 - a. Damper Actuator: 24-volt AC, powered closed, spring return open.
 - b. Provide transformer to step down incoming voltage to 24-volt, service disconnect switch, low voltage fuse and fuse block, line voltage disconnect switch, and line voltage fuse and fuse block.
 - c. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain airflow dictated by thermostat with 5 percent of set point while compensating for inlet static pressure variations up to 4 inch (1000 Pa); shall be suitable

for either reverse acting or direct acting and field adjustable for either normally open or normally closed damper position. The controller shall have auxiliary flow setpoint to be referenced through contact input and provide line velocity readout.

- d. Thermostat: Wall mounting electronic thermostat, with concealed cover latches to prevent tampering and adjustable stops for locking or limiting temperature setpoint slider movement.

2.19 DIFFUSERS, REGISTERS, AND GRILLES

A. Acceptable Manufacturers:

1. Diffusers, Registers, and Grilles

- a. Titus
- b. Price Industries
- c. Anemostat
- d. Tuttle & Bailey
- e. Krueger
- f. Carnes

2. Laminar Flow Diffusers:

- a. Price Industries
- b. Anemostat
- c. Precision Air Products
- d. Krueger

B. General:

1. Provide terminals of type and quantity as indicated on the drawings. Sizes and deflection patterns are shown for general guidance. Approved manufacturer shall be responsible for adjusting sizes to meet noise and throw performance requirements for CFM indicated.
2. Provide air terminals that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size and type device as listed in manufacturer's current data. Rate in accordance with ADC standards and certify catalogued performance.
3. Provide blow direction to direct air away from walls, columns, or other obstructions within radius of supply air terminal operation.

C. Performance requirements: Base selection on maximum residual air velocity in breathing zone of 35 feet per minute and on space noise level of NC 35 unless otherwise indicated.

D. Ceiling and Wall Compatibility:

1. Refer to architectural drawings and general specifications for types of ceiling and wall systems and coordinate the specific ceiling and wall type at the location where air terminals are to be installed. Provide border styles compatible with ceiling and wall type that are specifically manufactured to fit into ceiling module with accurate fit and adequate support.
2. Air terminals installed in T-bar grid framed ceilings: Provide panel type frame sized to fit within lay-in tile grid system. For tegular tile ceilings, provide drop face terminal to align with ceiling surface.

3. Air terminals installed in Spline, or inverted T-bar, grid framed ceilings: Provide drop face panel type sized to fit within lay-in tile grid system and aligning with ceiling surface.
4. Air terminals installed in hard gypsum ceilings: Provide frame with gasket seal suitable for attachment to gypsum ceiling.
5. Air terminals installed in walls: Provide wall mounted terminals suitable for installation in concrete block or drywall partition.

E. Ceiling Diffuser (CD):

1. Fabricate of steel or aluminum. 4-way blow pattern unless otherwise indicated, square flat panel face, each side to deliver quantity of air proportional to area served. Removable inner core for access to damper. Round or square duct collar connection as indicated, minimum 2 inch collar for duct connection.
2. Provide multi-blade equalizing deflector and adjustable opposed blade damper in collar of diffuser. Damper blades and adjustment lever shall be secured tight within frame to prevent incidental rattling of blades at normal airflow. Damper adjustable through face of diffuser.
3. Finish: Factory applied baked on white enamel to match ceiling grid.

F. Perforated Face Diffuser (PFD):

1. Fabricate of steel or aluminum. 4-way blow pattern unless otherwise indicated, fixed louver diffuser core. Hinged removable perforated face with 3/16-inch diameter holes on ¼ staggered centers and no less than 51% free area. Diffuser back pan shall be one-piece stamped heavy gauge metal. Round or square duct collar connection as indicated, minimum 2-inch collar for duct connection.
2. Adjustable pattern deflectors shall be mounted in diffuser core. Deflectors attached directly to perforated face will not be accepted. Include integral volume damper in the neck of the diffuser, adjustable from the face of the diffuser.
3. When used for return intakes; similarly constructed except without pattern deflectors. Grilles provided without volume dampers.
4. Finish: Factory applied baked on white enamel to match ceiling grid.

G. Registers and Grilles:

1. Provide outlets and intakes indicated as registers with adjustable key operated, multi shutter, streamlined contour, opposed blade dampers adjustable from face of register. Provide outlets and intakes indicated as grilles of same construction as registers except without dampers.
2. Fabricate of steel with minimum 20-gauge frame and 22-gauge blades, or aluminum of equivalent gauge. Fabricate entire assembly of stainless steel where indicated. Provide countersunk fastening screws on frame.
3. Intakes: Fabricate with streamlined, horizontal fixed bar grille face with bars set at 40 deg angle, turned down for low sidewall and turned up for high sidewall.
4. Outlets: Fabricate with streamlined, individually adjustable, double deflection grille faces with horizontal face bars.
5. Finish: Factory applied baked on enamel finish. Matte white to match ceiling grid.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible," unless otherwise indicated, for the specified duct pressure classification with the fewest possible joints.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. On ductwork subject to internal condensation, pitch horizontal runs towards equipment, or source of moisture, minimum 1/8 inch per foot slope.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- L. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Firestopping materials and installation methods are specified in Division 07.
- M. Install ducts with hangers and braces in accordance with Division 23 "Vibration Isolation and Seismic Restraints for HVAC Systems".
- N. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized- steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.2 SEAM AND JOINT SEALING

- A. Seal all duct seams and joints according to SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible" for duct pressure class indicated, and SMACNA's "HVAC Leakage Test Standards" for leakage and seal class indicated.
 - 1. For pressure classes 2-inch wg and lower, seal transverse joints.
- B. Seal ducts before external insulation is applied. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

3.3 FLEXIBLE DUCT INSTALLATION

- A. Use only where shown on the drawings, installed in accordance with SMACNA's "HVAC Duct Construction Standards" except as specified herein.
- B. Do not install flexible duct on return or exhaust ductwork unless specifically noted on drawings.
- C. Minimum length 48 inches and maximum length of 72 inches. Install runs with minimum centerline radius of bends not less than twice duct diameter and with no more offsets than an equivalent 90° elbow. Provide band strap hangers with saddle supports under flexible duct run to keep supports from sagging and kinking. Stretch duct enough to smooth out internal corrugations.
- D. Connect both ends to collar of rigid ductwork and air delivery device with sheet metal screws in addition to an approved stainless steel worm gear draw band. Plastic tie straps are not permitted.

3.4 FLEXIBLE CONNECTORS INSTALLATION

- A. Provide flexible connections immediately adjacent to fans, and externally isolated air handling units, to isolate and prevent transmission of vibration to ductwork and casings.
- B. Connections shall be made with a 3-inch space between duct and equipment collars, installed in line, and with 1 1/2-inch excess material folded so as not to interfere with airflow through connection. Flexible connectors are not permitted as a means for correcting misalignment.
- C. Do not install flexible connectors on internally isolated air-handling units.

3.5 VOLUME DAMPERS INSTALLATION

- A. Provide volume dampers at all points on low pressure supply, return and exhaust systems where branches are taken from larger ducts as required for air balancing. Do not install volume dampers upstream of air volume control boxes in any circumstance.
- B. Install volume damper as close to main as possible, minimum 2 duct widths from branch takeoff.
- C. Install damper in acoustically lined ducts in such a manner to avoid damage to liner and to avoid erosion of duct liner.

- D. Install orange ribbon tag tied on to volume damper handle for the purpose of visibly identifying volume damper locations.

3.6 ACCESS DOORS INSTALLATION

- A. Install duct access doors to allow inspecting, adjusting and cleaning duct mounted accessories where shown on drawings and as follows:
 - 1. Upstream and downstream of coils, filters, fans, humidifiers, control dampers, airflow measuring devices.
 - 2. Downstream of air volume control boxes.
 - 3. Adjacent to fire and fire/smoke dampers, providing adequate access to reset or reinstall fusible link.
 - 4. Adjacent to fire/smoke dampers, providing adequate access to damper actuator/motor.
 - 5. As required by NFPA requirements for duct cleaning.
- B. Where access doors are required within shaft enclosures or above inaccessible ceilings, coordinate with General Contractor and advise proper location of access panel.
- C. Identify all fire damper access doors by stenciling with bright red paint the words “FIRE DAMPER ACCESS”. For spring closure dynamic curtain type fire dampers use the words “CAUTION – DYNAMIC FIRE DAMPER ACCESS”.

3.7 AIR VOLUME CONTROL BOX INSTALLATION

- A. Install connecting piping to allow access to unit mounted controller and access panel.
- B. Connecting tubing and/or wiring for box installed in return air plenum ceiling to be “plenum rated” of type approved by applicable building code and local authority having jurisdiction for installation in ceiling air plenum.
- C. Install straight run, minimum of 1-1/2 duct diameters but not exceeding 2-1/2 duct diameters of rigid duct connection to inlet, full size of inlet connection. Fan powered units shall be connected with flexible connections on inlet and outlet. Inlet flexible connection shall be located upstream of straight run section, not at box collar connection.
- D. Provide hanger support for air volume control boxes independent of ductwork.

3.8 AIR TERMINAL INSTALLATION

- A. After installing terminal in ceiling grid, provide 12-gauge support wire fastened independently to structure. One wire for each device weighing 10 pounds or less, two wires (opposite corners) for device weighing 11 to 55 pounds, four wires for device weighing greater than 55 pounds. Wire shall not be in tension to lift device out of grid, but with minimal slack to allow device to sit on grid.

3.9 INSTRUMENT TEST HOLES INSTALLATION

- A. Install instrument test holes where shown on the drawings and in the following locations:
 - 1. Air handling unit supply duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate location with TAB Contractor.
 - 2. Return fan duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate with TAB Contractor.
 - 3. Exhaust fan duct mains.
 - 4. Downstream of duct mounted coils.
 - 5. Downstream of air volume control boxes.

3.10 DUCT MOUNTED SMOKE DETECTORS INSTALLATION

- A. Install duct mounted smoke detectors furnished by Division 28. Obtain installation instructions and install in accordance with manufacturer's instructions. Mount on ductwork at locations indicated on the drawings.

3.11 DUCT HANGERS AND SUPPORTS INSTALLATION

- A. Suspend and support ductwork, casings, and equipment in accordance with requirements of SMACNA Duct Construction Standards and as specified further in Sections 23 05 00 and 23 05 48, except as specified herein.
- B. No hangers shall be attached to or suspended from any type of metal deck. Attachments made beneath metal deck areas may be made by positive fastening to building structural members (excluding bridging and bracing) in conjunction with the use of miscellaneous auxiliary structural steel. All such steel shall conform to ASTM A36. Attachments relying on friction are not permitted.
- C. Whenever the distance between the top of duct and overhead supporting member is greater than 36 inches, the hangers shall be of structural angles or channels and shall include cross bracing as required to prevent sway. Do not use straps or rods.
- D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection. Support vertical ducts at a maximum interval of 12 feet and at each floor.
- E. Hangers must be arranged to allow the duct insulation to pass through without insulating any part of the hanger.
- F. Unless combined pipe/duct racks are shown on the drawings, provide dedicated hangers for support of ductwork.

3.12 EXTERIOR WALL LOUVER PLENUM INSTALLATION

- A. Exterior wall louvers for exhaust/intake/relief air will be provided by Division 08.

- B. Unless otherwise indicated, provide shop or field fabricated casings and plenums as specified elsewhere in this section for connection to exterior wall louvers. Where the connecting plenum is smaller than actual louver size, provide insulated blank off panel(s) for unused portions behind louver.
- C. Insulate plenum/casing as specified in 23 07 00.
- D. For suspended plenums, slope bottom of plenum down towards face of louver, minimum 1/8 inch per foot, and provide adequate flashing or weep holes at louver frame to allow entrained water to drain out through louver face.
- E. Blank off panel shall be double wall construction with internal insulation having a total R value of not less than R-13. Fabricate of aluminum of gauge required by SMACNA for size of blank off required, 18 gauge minimum. Insulation shall be moisture proof, non-wicking, mildew resistant and shall comply with ASTM E84 Flame Spread and Smoke Developed ratings.
- F. Blank-off panels shall be mounted directly behind louver blades and shall be integral with the flashing at the bottom of the louver.

3.13 CLEANING AND PROTECTION

- A. Thoroughly clean all air stream surfaces of all equipment, devices and accessories in the air distribution systems and all air stream surfaces of ductwork, casings and plenums and maintain in a clean condition as the work progresses. Clean ductwork piece by piece, section by section as installed.
- B. Protect openings of all equipment, devices and accessories with polyethylene film or another covering to prevent entrance of moisture, dust or debris until final ductwork/casing/plenum connections are made. Similarly protect openings in ductwork, casings and plenums.
- C. After installation, either force air at high velocity through systems or use high power vacuum machines to remove accumulated dust. Protect equipment which may be harmed by dirt with filters, or bypass during cleaning. Provide adequate access into ductwork/casings/plenums for cleaning.
- D. Clean external surfaces of all of the above of foreign substances which might cause corrosive deterioration of metal or, where to be painted, might interfere with painting or cause paint deterioration.
- E. Wipe clean all air terminal units from dust entrained on face during construction.

3.14 FIELD QUALITY CONTROL

- A. Perform duct leakage testing and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports.
- B. Test all high and medium pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork.
- C. Test all low pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork.

- D. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- E. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. Do not pressurize systems above maximum design operating pressure.
- F. Conduct tests in the presence of TAB Contractor. Give seven days' advance notice for testing.
- G. Maximum Allowable Leakage: Total leakage for pressure class shall not exceed permissible leakage for specified seal and leakage class.
- H. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 23 30 00

SECTION 23 34 00 – FANS AND VENTILATORS

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. In-Line Centrifugal Fans
2. Centrifugal Downblast Fans
3. Ceiling Exhaust Fans

- B. Related Sections:

1. Motors are specified in Division 23 “Electrical Requirements for HVAC Equipment.”
2. Variable speed motor speed controllers furnished by Division 23 are specified in Division 26.

1.3 PERFORMANCE REQUIREMENTS

- A. Base fan performance on sea level conditions unless noted otherwise.
- B. Provide fans capable of accommodating static pressure variations of plus/minus 10 percent at scheduled airflow.
- C. Fans and shafts statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
- D. Equivalent fan selections shall not increase motor horsepower (wattage) from that specified and shall not increase noise level and tip speed by more than 10 percent or increase inlet or discharge air velocity by more than 20 percent.
- E. Fan Class: If the fan selection indicates an operating point within 10 percent of maximum operational speed (RPM) limit for the fan class indicated by the selection point, provide fan with next higher-class designation.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated. Provide multiple RPM curves. Single RPM curves not acceptable for belt driven fans or variable speed fans.
 2. Certified fan sound-power ratings.
 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 4. Material thickness and finishes, including color charts.
 5. Dampers, including housings, linkages, and operators.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. 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.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FAN

A. Acceptable Manufacturers:

1. Loren Cook
2. Penn Ventilator
3. Greenheck

B. Description: Centrifugal, of all aluminum construction, with housing, fan wheel, shaft, grease lubricated ball bearings, motor and accessories. Class as indicated or required. Direct-drive as scheduled.

C. Housing: Housing fabricated from one piece or split spun aluminum and provided with removable spun inlet collar to match wheel inlet cone, outlet guide vanes, gasketed access door or plate, raised type for insulated housing, flanged inlet and outlet duct connections with, if required, companion flanges and with mounting brackets suitable for floor, ceiling or vertical installation as required for application.

D. Single-width single-inlet (SWSI) wheel with backwardly inclined or airfoil type non overloading blades welded to side and back plates, spun inlet cone, cast-aluminum hub keyed to shaft.

E. Direct Drive Unit: Motor encased in housing outside of airstream and factory wired to external terminal box.

F. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Bolted gasketed door allowing access to fan scroll, of same material as housing.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

G. Motors: Comply with requirements in Division 23 Section "Electrical Requirements for HVAC Equipment."

H. Vibration Isolation: Refer to Division 23 "Vibration Isolation and Seismic Restraints For HVAC Systems."

2.2 CENTRIFUGAL DOWNBLAST FAN

A. Acceptable Manufacturers:

1. Penn Ventilator
2. Loren Cook

3. Greenheck
 4. Hartzell Fan Inc
- B. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains, square, one-piece, aluminum base with venturi inlet cone. Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent for direct drive fans.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, back draft dampers mounted in curb base; factory set to close when fan stops.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Overall Height: 12 inches
 2. Sound Curb: Curb with sound-absorbing insulation matrix.
 3. Metal Liner: Galvanized steel.
 4. Mounting Pedestal: Galvanized steel with removable access panel for access to backdraft damper.
 5. Vented Curb: Unlined with louvered vents in vertical sides in compliance with NFPA 96 for use with cooking hood.

2.3 CEILING EXHAUST FAN

- A. Acceptable Manufacturers:
1. Penn Ventilator Company
 2. Greenheck
 3. Loren Cook
- B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- C. Housing: Steel, lined with acoustical insulation.

- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 2. Isolation: Rubber-in-shear vibration isolators.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: 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.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install centrifugal fans level and plumb. Install units with clearances for service and maintenance.
- B. Support suspended units from structure using threaded steel rods and vibration isolators as specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."
- C. Install roof mounted fans on roof curbs or roof support rails as indicated. Support fans mounted on roof rails using vibration isolators as specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."
- D. Make final duct connections with flexible connectors. Install ducts adjacent to fans to allow service and maintenance.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Adjust damper linkages for proper damper operation.
 5. Verify lubrication for bearings and other moving parts.
 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 7. Refer to Division 01 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
 8. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 34 00

SECTION 23 60 00 – WATER CHILLERS

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. Air Cooled Liquid Chiller
- B. Related Sections include the following:
 - 1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors.
 - 2. Division 23 Section “Vibration Isolation for HVAC Systems”.

1.3 DEFINITIONS

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

1.4 REFERENCES

- A. ANSI/ASHRAE 15: Safety Code for Mechanical Refrigeration
- B. AHRI 550/590: Centrifugal, Rotary Screw and Reciprocation Water Chilling Packages
- C. AHRI 560: Absorption Water Chilling Packages

- D. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
- E. NFPA 70: National Electric Code
- F. NEMA ICS-6: Enclosures for Industrial Controls and Systems
- G. UL: Underwriters Laboratories, applicable standards
- H. ETL: Electrical Testing Laboratories, applicable standards

1.5 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Complete set of manufacturer's certified prints of equipment assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Operating weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Certificates: For certification required in "Quality Assurance" Article.
- D. Source quality-control test reports.

1.6 WARRANTY

- A. Special Warranty: Provide extended warranty or warranty service as specified in this section.

1.7 MANUFACTURER'S SUPERVISION/INSPECTION SERVICES

- A. Water Chiller
 - 1. Provide services of manufacturer's factory trained field engineer to supervise installation of unit and witness pressure testing, evacuation and charging. Manufacturer's field engineer shall also perform initial startup including proper coordination with Contractor on startup of cooling tower and associated condenser water and chilled water pumps.
 - 2. When chiller is shipped in sections, manufacturer shall properly field charge assembled system.
 - 3. Following test, startup, adjustment and balancing, manufacturer's engineer shall instruct Owner or his representative in proper care and operation of unit for a period of 2 days, continuous or intermittent at option of Owner.
 - 4. Following test, startup, adjustment and balancing, manufacturer shall certify, in writing, that the equipment is installed in accordance with his requirements and is operating in accordance with the intent of the specifications.

1.8 QUALITY ASSURANCE

- A. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- B. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Comply with NFPA 70.
- D. Comply with UL 1995.
- E. Rating temperatures and conditions, COP and EER of all equipment and components provided under this section shall meet the requirements of the State Energy Code or latest issue of ASHRAE Standard 90 or the latest issue of the Standards for Equipment of the National Energy Policy Act, whichever is more stringent.

1.9 COORDINATION

- A. Centrifugal Water Chiller: Contractor for DIVISION 26, ELECTRICAL, will install chiller motor starter(s) and will provide power wiring from source to chiller motor starter(s) and motor(s). DIVISION 26, ELECTRICAL shall provide wiring from the chiller control panel to the chiller starter and including wiring from flow switches to safeties.

1.10 SOURCE QUALITY CONTROL

- A. Water chillers shall receive factory performance test as specified. All tests to be witnessed by the Owner's representative. Manufacturer shall provide minimum two weeks prior notice of test date.
- B. Include test procedures and results of chiller performance tests in final book to the Owner.

1.11 DELIVERY OF EQUIPMENT

- A. Equipment manufacturer shall prepare units for shipment. Units shall be fully cleaned and plastic wrapper prior to shipment. Provide instructions for assembly as required.
- B. Ship water chillers from the factory fully charged with refrigerant or nitrogen.
- C. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 AIR COOLED LIQUID CHILLER (SCROLL)

A. Acceptable Manufacturers:

1. Trane
2. York / Johnson Controls, Inc.
3. Carrier
4. Daikin / McQuay

B. General

1. Complete factory assembled, including scroll compressors, condenser coils, fans and motors, controls charged with oil and refrigerant ready for installation and use. Units shall be UL or CSA certified and rated in accordance with AHRI Standard 550/590.
2. Chiller shall include single or multiple refrigerant circuits suitable for capacity modulation. Refrigerant circuits independently piped and complete with liquid line solenoid valve, filter drier, liquid line sight glass with moisture indicator, thermostatic expansion valve, and service valves (liquid and discharge). For multiple refrigerant circuits, capacity modulation is achieved by staging the compressors on and off.
3. Factory run tested to confirm performance and proper operation.
4. Chiller shall operate using refrigerant R-410A.

C. Cabinet

1. Units are constructed of 14 gauge welded galvanized steel frame with minimum 16-gauge galvanized steel panels and access doors. Unit surface is phosphatized and finished with manufacturers recommended finish, which withstands a 1000 consecutive hour salt spray in accordance with ASTM B117.

D. Evaporator:

1. Evaporator tube of brazed plate construction designed to withstand 150 psig waterside working pressure and 225 psig refrigerant side working pressure. Evaporator equipped with heater for freeze protection down to -20 deg. F ambient.
2. Water inlet and outlet connections grooved end victaulic couplings.
3. Insulation: Manufacturer shall be responsible to field insulate unit with minimum 3/4-inch closed cell (antisweat) insulation applied to cooler, float chamber and piping, compressor suction piping and other low temperature surfaces subject to sweating.

E. Compressor and Motor

1. Compressor shall be scroll type direct drive, 3600 RPM, suction gas cooled hermetic motor.
2. Provide centrifugal oil pump, oil level sight glass and oil charging valve.
3. Provide crankcase heater properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
4. Provide hot gas bypass capacity control, for stable operation as low as 5% capacity.

F. Air Cooled Condenser:

1. Fin and tube condenser coils of seamless copper tubes mechanically expanded into aluminum fins. Design working pressure of 450 psig, factory pressure tested.
2. Condenser fans shall be corrosion resistant material, direct drive independent motors designed for maximum efficiency. Vertical discharge, statically and dynamically balanced for vibration free operation. Provide corrosion resistant fan guards constructed of heavy gauge coated steel. Motors shall be totally enclosed air over (TEAO), squirrel cage type. Ball bearings permanently lubricated.

G. Controls

1. Control panel shall be contained in a NEMA 3R/12 cabinet with hinged outer door.
2. Provide flow switches.

H. Power Connections

1. Power Panels:
 - a. NEMA 3R/12 (P55) rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor and fan motor start contactors, current overloads, and factory wiring.
 - b. Field power supply wiring connections shall be to a single power center on the chiller, shall be 3 phase of scheduled voltage, and shall connect to terminal blocks per each of the two motor control panels. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.
 - c. Provide two electrically separate, adjacent motor control center cabinets, with independent doors and separated by a steel panel, for compressor and fan motor power distribution components.
2. Exposed compressor and fan motor power wiring shall be routed through liquid tight conduit.

I. Accessories and Options

1. Power Supply Connections
 - a. Single Point or Multiple Point Supply Terminal Block with Circuit Breakers
 - b. Single Point or Multiple Point Non Fused Disconnect Switches
 - c. Single Point Non-Fused Disconnect Switch with individual circuit breakers
 - d. Single Point Circuit Breaker
2. Low Temperature Brine: Provide suitable for operation for chilling brine below 30 deg F.
3. Sound attenuating package including blanket wrapped compressors, and low RPM condenser fans.
4. Condenser coil protective coating where installed in maritime environments.

J. Hydronic Pumping Package

1. Provide complete pumping package including the following components mounted on an integral skid.
 - a. Dual pump[s] as scheduled.
 - b. Variable speed drive for each pump
 - c. Power feed for the pump[s] to be part of the chiller single point connection.
 - d. For each pump provide a balancing valve, isolation valves, check valve, strainer, upstream and downstream pressure gauges
 - e. Expansion tank as scheduled

PART 3 - EXECUTION

3.1 CHILLER INSTALLATION

- A. Install chillers on concrete base.
- B. Charge chiller with refrigerant if not factory charged.
- C. Provide water piping and accessories for water cooled oil cooler.
- D. Pipe discharge from relief valve and purge to exterior of building.
- E. Install temperature sensor, chilled and condenser water flow and differential switches and other devices not specified or not furnished as factory installed.
- F. Provide union/flanged piping connections and arrange piping risers to allow head removal for tube cleaning or replacement with minimal disturbance to piping connections. Provide drain and vent valves for evaporator and condenser.
- G. Leave adequate pull space at the end of unit where access is required for tube pulling.
- H. Connect wiring and electrically ground water chillers according to Division 26. 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 and UL 486B.
- I. Start Up Service:
 1. Engage a factory authorized service representative to perform startup service.
 2. Inspect field assembled components, equipment installations, and piping and electrical connections for proper assemblies, installations and connections.
 3. Complete startup checks according to manufacturer's written instructions and perform the following:
 - a. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - b. Verify that pumps are installed and functional.
 - c. Verify that thermometers and gages are installed.
 - d. Operate water chiller for run-in period according to manufacturer's written instructions.
 - e. Check bearing lubrication and oil levels.

- f. Verify that refrigerant pressure relief is properly vented.
 - g. Verify proper motor rotation.
 - h. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
 - i. Verify and record performance of water chiller protection devices.
 - j. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
4. Prepare a written startup report that records results of tests and inspections.

END OF SECTION 23 60 00

SECTION 23 70 10 – COMMERCIAL INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes commercial indoor air handling units
- B. Related Sections include the following:
 - 1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors and variable frequency motor speed controllers.

1.3 REFERENCES

- A. AGA: Applicable publications
- B. AMCA-210: Laboratory Methods of Testing Fans for Rating
- C. AMCA-500: Test Method for Louvers, Dampers and Shutters
- D. AHRI-410: Forced Circulation Air-cooling and Air-heating Coils
- E. AHRI-430: Central Station Air Handling Units.
- F. ASHRAE 90.1: Energy Standard for Buildings, Except Low-Rise Residential Buildings
- G. NBS: Applicable standards
- H. NEC: National Electric Code
- I. NFPA: Applicable standards
- J. UL: Applicable standards

1.4 SUBMITTALS

- A. Product Data: For each type of air-handling unit indicated, include the following:
 - 1. Certified fan-performance curves with system operating conditions indicated. Submit multiple RPM fan curve, single RPM fan curve not acceptable.

2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.
8. Internal pressure drop calculation tabulating each component, including dirty filter allowance, include inlet and outlet openings.
9. Wiring diagrams: Power and control wiring as applicable.

B. Shop Drawings: Provide a detailed fabrication drawing for each air handling unit, drawn accurately to scale, clearly indicating installation of all components, accessories, and unit connections, when assembled as a complete unit. Include unit dimensions and operating weights. Shipping splits shall be indicated as applicable.

1.5 WARRANTY

A. Special Warranty: Provide extended warranty and/or warranty service where specified elsewhere in this section.

1.6 MANUFACTURER'S SUPERVISION/INSPECTION SERVICES

A. Air Handling Units

1. The manufacturer shall be present during field installation or shall inspect completed installation of all air handling units and shall certify in writing that the installation is in accordance with their requirements and the units will function properly and operate in accordance with the intent of the specifications.
2. The manufacturer shall include the cost of furnishing the services of a factory trained representative to supervise the initial startup and testing of all air handling units.
3. Following test, startup, adjustment and balancing, the manufacturer shall also provide the services of a factory trained representative for instruction of the Owner's personnel in the operation and maintenance of the equipment.

B. Variable Frequency Motor Speed Controller for Air Handling Units

1. Provide the services of the manufacturer's engineer or authorized serviceman to check, start-up, test and adjust controller and to assist the TAB Contractor and BAS Contractor in setting up controls for the variable speed controller.
2. The manufacturer's engineer or authorized serviceman shall: Check the equipment for proper installation and for its conformance to the Specifications; run the system in all modes of operation to ascertain that the unit will function properly; test the system for line noise and radio interference and furnish test report; make necessary adjustments to ensure trouble-free service.
3. After completion of the start-up procedure, the manufacturer shall certify in writing, that the equipment is installed in accordance with his requirements and is operating in accordance with the intent of the Specifications and shall instruct the Owner in proper operation and maintenance of the variable speed controller.

1.7 QUALITY ASSURANCE

- A. Drawings indicate size, profiles, and dimensional requirements of air-handling units and are based on one manufacturer. Other manufacturer's dimensions and weights that deviate from the basis of design are acceptable provided that there is no impact to the general layout, structural design, and accessibility requirements indicated on the documents. Division 23 Contractor shall be fully responsible to coordinate all changes.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- D. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
- E. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate with Division 26 for the required unit power connections, including any internal wiring of lights and receptacles not factory wired.

1.9 DELIVERY OF EQUIPMENT

- A. Equipment manufacturer shall prepare units for shipment. Identify each component and mating planes. Units shall be fully cleaned and completely dry, and plastic shrink wrapped for each shipping section. Provide instructions for assembly.
- B. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.
- C. Contractor shall inspect equipment on receipt and report any damage to the Owner in writing. Barring such written notification, Contractor shall be fully responsible for and shall repair at his own expense any damage to the equipment resulting from his receipt, unloading, storage if necessary, and installation of the equipment.
- D. Equipment manufacturer shall provide a trained field technician to supervise assembly of air handling units in the field.

PART 2 - PRODUCTS

2.1 HEAT TRANSFER COIL FOR AIR HANDLING UNIT

- A. Water and Steam Coils: Manufacturer to be selected by and complete responsibility of air handling unit manufacturer.

- B. Extended surface type constructed of copper tubes with aluminum fins. Coil headers of steel, copper or cast iron unless otherwise specified. Header and nipple designed and constructed to prevent electrolytic corrosion. Tubes staggered in direction of air flow. Fin spacing 10 fins per inch maximum for cooling coils unless indicated otherwise. Coil rating certified in accordance with AHRI 410.
- C. Water Coils
 - 1. Cooling Coils: 1/2-inch o.d. x 0.016-inch tube wall.
 - 2. Coil headers of steel, copper or cast iron unless otherwise specified.
 - 3. Coils for cooling service (chilled water) constructed of plate type fins with tubes mechanically or hydraulically expanded into fins to form a permanently tight metal to metal contact.
 - 4. Provide coils with supply and return connections on the same end of coil.
- D. Maximum coil face velocities or minimum coil areas and minimum rows deep are noted on Drawings. Increase face area or rows as required to meet scheduled performance, not fins per inch.
- E. Casings: Construct casings and tube sheet of type 304 stainless steel for cooling coils, galvanized sheet steel elsewhere, with intermediate tube supports for coils exceeding 48 inch tube length. Tube sheets and intermediate tube supports to have either extruded holes or ferruled holes.

2.2 COMMERCIAL INDOOR AIR HANDLING UNIT

A. Acceptable Manufacturers:

- 1. Daikin
- 2. York
- 3. Trane
- 4. McQuay
- 5. Carrier

B. General:

- 1. Air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and accessories as specified herein. Suitable for operation at scheduled static pressure. Fan and coil performance AHRI certified whenever AHRI offers such certification.
- 2. Manufacturer shall guarantee performance of cooling coil(s) such that no moisture carryover will occur on downstream components. Provide moisture eliminator at discharge of cooling coil if required to prevent moisture carryover.
- 3. Provide access sections of sufficient length between unit components to ensure proper performance and airflow across all surfaces as well as sufficient distance for maintenance and service access.
- 4. Air handling unit total static pressure indicated on the drawings is approximately only. Manufacturer shall be responsible to confirm internal pressure drop for each component of the unit, including system effects, and combined with scheduled external static pressure, determine total fan pressure drop for the basis of fan selection. Include filter manufacturer's recommended dirty filter pressure drop in total pressure drop calculations.

C. Casing:

1. Construct entire casing of unit of galvanized steel with double wall thermal barrier system. Unit casing to have solid inner walls constructed of 22 gauge and solid outer walls constructed of 18-gauge galvanized steel with galvanized steel support members. Perforated inner wall will not be accepted.
2. Floor shall be 16-gauge galvanized steel, except stainless steel required under cooling coils and humidifiers.
3. Provide insulated double wall sloped drain pan under cooling coils and humidifier, to comply with ASHRAE 62. Fabricate drain pans from single sheet with welded corners. Fabricate full inner pan of stainless steel and outer pan of galvanized steel. Either provide stainless steel moisture eliminator or extend drain pan sufficient distance downstream of cooling coil to collect all condensed moisture when units are operating at maximum catalogued face velocity across cooling coil. Extend drain connection(s) to exterior of unit casing.
4. Mount equipment and support exterior steel panels from welded and bolted, heavy structural steel frame. Exterior panels nonload bearing to allow removal of panels without effecting structural integrity of unit. Sheet metal screws or similar type fasteners will not be permitted for frame. Reinforce larger panels as required to provide rigidity.
5. Provide lifting lugs.

D. Insulation:

1. Insulate entire unit between inner and outer panels with 2-inch-thick polyurethane foam insulation conforming to NFPA 90A and NFPA 90B.
2. Thermal conductivity (k value): 0.18 at 75 deg. F.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C411.

E. Access Panels and Doors:

1. Provide access doors of same construction as unit casing, complete with hinges, latches, handles, and gaskets. Access doors shall be sized and located to allow periodic maintenance and inspections. Doors shall be fully gasketed and open against unit pressure. Provide access doors for each access section. Provide minimum 6-inch by 8- inch view window made with safety wire reinforcement for fan section and elsewhere as indicated on drawings.
2. Provide access panels of same construction as unit casing to allow removal of components such as coil(s) and fans. Access panels shall be bolted and gasketed to be removable as well as airtight.

F. Fans, Motors, and Drives:

1. Provide fan assembly consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support frame equipped with formed steel channel base for integral mounting of fan and motor.
2. Fan assemblies statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
3. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

- a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - b. Performance Class: AMCA 99-2408, Class suitable for scheduled operating condition.
 - c. Horizontal Flanged Split Housing: Bolted construction.
4. Fan Assemblies:
- a. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.
 - 1) Fan array shall be equipped with piezometer points to measure airflow. One piezometer point shall be supplied on each fan in the fan array.
 - 2) Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
 - 3) Motor control panel shall come equipped with a fused disconnect.
 - 4) Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
 - 5) Motor shall be brushless DC type with a permanent magnet rotor.
 - 6) Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.
 - 5. Shafts: Turned, ground, and polished hot rolled solid steel with keyway. Ship with protective coating of lubricating oil. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 6. Provide self-aligning oil or grease lubricated pillow block type ball bearings with adaptor mount and two-piece, cast-iron housing. Minimum L-10 life of 50,000 hours. Provide suitable lubrication fittings.
 - 7. Fan Speed Control: Where scheduled, provide variable frequency motor speed controller as specified in Division 23 Section "Electrical Requirements for HVAC Equipment".
 - 8. Include with submittals multiple RPM fan curve with operating point plotted on curve. Single RPM curve not acceptable. Equivalent fan selection shall not increase motor horsepower (wattage) and shall not increase noise level and tip speed by more than 10 percent or increase inlet or discharge air velocity by more than 20 percent.
 - 9. Sound Performance: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

G. Vibration Isolation

- 1. Install entire fan, motor and drive assembly on a structural steel vibration isolator base and isolate by use of springs, internally mounted at factory, together with fan discharge flexible connection and thrust restraint springs.
- 2. Isolation devices shall comply with Division 23 "Vibration Isolation for HVAC Systems".

H. Filters

- 1. Furnish combination filter section with 2-inch pleated MERV 8 flat pre-filter and 4-inch final filter. Provide side loading and removal of filters.

2. Filter media shall be UL 900 listed, Class I or Class II.

I. Coils

1. Construct coil(s) as specified elsewhere in this Section under “Heat Transfer Coil for Air Handling Unit”.
2. Provide cooling coil support racks constructed of stainless-steel structural members.
3. Where coils are stacked more than one high, provide individual coil support racks to allow easy removal of a lower coil without disturbing the upper coils. For stacked cooling coils, provide independent stainless steel support racks and intermediate stainless-steel drain pan with downspout for each upper coil.
4. Extend coil connections through unit casing to the exterior of unit. Seal casing penetrations airtight.

J. Gas Heat Module

1. The air handling unit shall include a natural gas heating section. The duct furnace shall be natural gas fired heating module(s) factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners. The heat exchanger tubes shall be constructed of stainless steel. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
2. Gas-fired duct furnaces provided shall have a tubular heat exchanger constructed of type 409 Stainless Steel .044 Min. Wall thickness produced to ASTM A268.
3. The Duct Furnace models shall be listed by Intertek Testing Services (ITS / ETL) for operation on Natural or Propane gas to the current edition of ANSI Z83.8 Standard for Gas-Fired Duct Furnaces. Duct furnaces are for installation on the positive pressure side of the circulating air blower, only.
4. Gas module shall have 5:1 modulating control.
5. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
6. Field installed heating modules shall require a field ETL certification. The manufacturer’s rooftop unit ETL certification shall cover the complete unit including the gas heating modules.
7. Individual Duct Furnaces shall incorporate a Direct Spark Ignition control module that is design certified by a recognized national testing agency. The control shall provide:
 - a. 100% safety shut-off.
 - b. A 15 second minimum pre-purge period prior to trial for ignition.
 - c. High energy direct spark ignition of main burners.
 - d. Electronic flame supervision incorporating a 0.8 second flame failure response time.
 - e. Up to 2 additional ignition retrials preceded by an interpurge period.
 - f. A minimum 30 second post-purge.
 - g. Automatic reset after one hour to initiate additional ignition trials if lockout occurs during heat call.
 - h. An LED indicator light to provide a flash code to identify the operating condition of the control.

K. Additional Sections

1. Access section shall be provided for access between components.
2. Mixing box section shall be provided with top outside air opening and end return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Verify that quantities and locations of balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation. Prepare a report that identifies any deficiencies and specifically note required work to be done to allow effective balancing.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- I. Examine plenum ceilings or raised floors used for supply air to verify that they are airtight. Verify that pipe and duct penetrations and other holes are sealed.
- J. Examine strainers for clean screens.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- P. Report deficiencies discovered before and during performance of TAB procedures. Record default set points if different from indicated values.

3.2 DUCTWORK LEAKAGE TEST VERIFICATION

- A. Installing Contractor will install ductwork as specified in Section 23 30 00 and will perform leakage tests. TAB Contractor shall witness all duct leakage tests.
- B. Verify and record that all duct sections have been tested, indicate both successful and unsuccessful tests. Verify sections where resealing and retesting resulted in successful tests. Include date of tests and initials of balancing technician who witnessed tests.

3.3 PREPARATION

- A. Complete system readiness checks and prepare system readiness reports. Include verification of the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB, and otherwise as specified in this Section.
- B. Obtain approved submittals for all equipment and devices required for proper system balancing. Balance systems to achieve capacities and flow quantities indicated on drawings and approved submittals. Should there be a conflict between the drawings and submittals, the approved submittal values shall be used.
- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed- control levers, and similar controls and devices, to show final settings.
- E. Take and report testing and balancing measurements in the same units, inch-pound (IP) or metric (SI), to match what is shown on Contract Documents.

3.5 BALANCING TOLERANCES

A. Air Balancing:

- 1. All measured air quantities shall agree with design air quantities within tolerances listed herein or otherwise acceptable to the Architect. The measurements recorded in the TAB Report for the total CFM of all branches, and the grand total shall agree with the measured air volume of the fan, less an air quantity not greater than the specified maximum percentage of leakage.
- 2. Balance all equipment, air outlets and air intakes in accordance with the air quantities shown on the drawings with permissible tolerances as follows:
 - a. Supply, return and exhaust fans
 - 1) Fan serving multiple rooms -5% to +10%
 - 2) Fan serving individual room $\pm 5\%$
 - b. Minimum outside air -0% to +5%
 - c. Terminal Units
 - 1) Terminal unit serving multiple rooms -5% to +10%
 - 2) Terminal unit serving individual room $\pm 5\%$
 - d. Air Outlets
 - 1) Room with multiple outlets $\pm 10\%$
 - 2) Room with individual outlet $\pm 5\%$

- B. Water Balancing: Balance all hydronic equipment, pumps, coils, etc in accordance with the capacities and flow quantities shown on the drawings within an acceptable tolerance of $\pm 5\%$.
- C. If during progress of the construction or during balancing, the TAB Contractor encounters any condition that will not allow balancing to be performed within the above balancing tolerances, the fact(s) shall be reported immediately to the Architect with recommendations for corrective action. If feasible, report such conditions and recommendations prior to submission of balancing reports. Work shall then proceed in accordance with the response provided by the Architect.

3.6 AIR SYSTEM BALANCING

- A. Prepare test reports for all air systems. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Locate start-stop and disconnect switches, electrical interlocks, motor starters, variable frequency motor speed controllers and DDC panels.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check condensate drains for proper connections and functionality. Confirm plenum pressure at trap connection and confirm trap depth and arrangement is in accordance with drawing detail.
- G. Check for proper sealing of air-handling unit components.
- H. Verify that clean filters have been provided by Installing Contractor. Simulate specified dirty filter condition when balancing.
- I. Provide pitot tube test openings with covers as required for taking pressure and velocity readings in ductwork. Install openings and covers of a type and in a manner to insure against leakage. Remove, replace and repair insulation at pitot tube test openings in a neat and workmanlike manner. Where permanent instrument test ports are specified, advise Installing Contractor as to proper location.
- J. Measure air quantities in main ducts by pitot tube traverse of the entire cross sectional area of the duct. Where air measuring stations have been installed, measure air quantities by pitot tube traverse and verify calibration of air measuring station. Do not use air measuring station for balancing purposes. Where necessary for proper balancing, make similar measurements in branch ducts. Determine outlet and inlet air quantities in accordance with outlet and inlet manufacturer's recommendations.
- K. Obtain total air quantities by adjustment of fan speeds or adjustment of belts and sheaves. Adjust branch duct air quantities by volume dampers. Permanently mark dampers after air balance is complete.
- L. Volume dampers shall be used to balance air quantities at outlets and inlets, providing final adjustments do not produce objectionable drafts or sound levels. Air quantity adjustments using outlet pattern deflectors will not be permitted.

M. Balancing variable air volume (VAV) systems:

1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set- point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Measure total system airflow. Adjust to within indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units.
3. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets.
4. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.
5. Balance at design (maximum) airflow and to deliver design minimum outside air at both design maximum and design minimum total airflow. Determine minimum fan speed and system static pressure that will satisfy requirements and advise BAS Contractor accordingly. Retest at simulated partial load conditions, at scheduled minimum airflow.
6. Record the final fan performance data at maximum and minimum flow conditions. Using fan curves obtained from approved submittals, plot maximum and minimum operating conditions on fan curve and include in final report.
7. Test variable frequency drives through full range of Hertz for operating points that cause excessive vibration due to harmonic frequency, and program VFD to prevent operation at those frequencies.

N. Outside Air and Relief Air (Economizer) Damper Setup Procedure:

1. All airflow station calibration should be checked prior to beginning procedure listed below.
2. These procedures should be performed during unoccupied hours, since building temperatures will not be maintained during the adjustment procedure.
3. Disassociate AHU relief air damper control signal from outside air damper and return air damper control signal. Relief air damper shall be modulated to maintain return fan discharge static pressure at setpoint (Relief air damper setpoint to be initially set to
4. +0.20”).
5. De-energize all associated exhaust fans.
6. Index outside air damper to 100% open and return damper to 100% closed.
7. Index all associated AVB boxes to maximum scheduled airflow (This should cause supply fan VFD to index to near maximum design speed).
8. Set supply/return differential setpoint to zero. Replace or adjust the return fan sheave so that at VFD maximum speed the return fan airflow is less than or equal to the scheduled return fan airflow.
9. Set supply/return differential setpoint to scheduled minimum outside air cfm (This should slow down the return air fan VFD). Disable economizer controls and reset outside air and return air dampers to automatic control (outside air damper should be at minimum position and return air damper should be mostly open).
10. Energize all associated building general exhaust fans.
11. Adjust return damper position to maintain 0.10” positive pressure in the return fan discharge ductwork (this should establish maximum return damper and minimum outside air damper

positions). Relief damper should be closed and the outside airflow sensor should now read near to the supply/return differential setpoint set in 8 above (There will be a difference due to flow sensor inaccuracy at low o/a flow).

12. Complete steps 1 to 10 above for each air handling unit. After completing set-up on all units, check return fan discharge pressure at each unit. The pressure should still be +0.1" at minimum outside airflow.
 13. Check building pressurization at front doors, if it seems to take excess pressure to open doors or if there seems to be an in rush of air when doors are opened, increase supply/return differential setpoints for each air handling unit by 5%. (Note: Only perform this step when there is little or no wind outside).
 14. Perform step 12 until the building is at a neutral or slightly positive pressure.
 15. Index all boxes to minimum scheduled airflow and check building pressurization at front doors (it should be the same as at the end of step 13).
 16. Index unit for 100% outside air and check building pressurization at front doors (again it should not change).
 17. Return all systems to automatic control and check building pressurization at the front doors (final check that building pressurization is the same as it was after step 13).
 18. After final set-up of all units is completed, submit to the owner a report containing:
 - a. Final supply/return differential setpoint for each unit.
 - b. Description of apparent building pressurization after AHU setup is completed.
 - c. One hour trend logs for each unit listing: supply air CFM, return air CFM, outside air CFM (as measured at o/a flow station), and return fan discharge static pressure. These readings shall be taken every 5 minutes for one hour after AHU setup is complete.
- O. Air Volume Control Boxes and Air Flow Measuring Stations: Check each terminal unit and air flow measuring station for calibration and adjust as necessary.
1. For Air Volume Control Boxes and Air Flow Measuring Stations with DDC Controls
 - a. BAS Contractor will set up and calibrate the mass flow control device to the design contract values.
 - b. BAS Contractor will index the system configuration as requested by TAB Contractor.
 - c. TAB Contractor shall then test the mass flow output and shall proportionately adjust the distribution. If the mass flow results deviate from the design intent by greater than the nominal ($\pm 5\%$) amount, TAB Contractor shall provide those values to BAS Contractor for final adjustment.
 - d. BAS Contractor will modify the previously mentioned correction factor to cause the controlled value to be consistent with the field measured value.
 - e. TAB Contractor shall then retest as required to confirm that such corrections have resulted in values that conform to the specification requirements.
- P. Diffuser Pattern Adjustment: Adjust individual outlets under procedures recommended by the manufacturers of the outlets, or as otherwise approved by Architect. Set pattern deflectors at each outlet for the air pattern required. Make changes in air patterns or settings necessary to achieve correct air balance and to minimize drafts. Bring to the attention of the Installing Contractor any air outlets with noticeable rattle caused by loose dampers or pattern adjusters.

3.7 AIR BALANCING DATA

A. Include the following data in the TAB Reports:

1. Air Moving Equipment Data

- a. Fan or Unit No.
- b. Location
- c. Area Served
- d. Manufacturer
- e. Model No. and Serial No.
- f. Rated and Actual Motor Data
 - 1) HP
 - 2) Phase
 - 3) Voltage
 - 4) Amperage
- g. Design and Actual Air Flow Measurements
 - 1) Total CFM
 - 2) Outside air CFM at minimum OA damper setting
 - 3) Total and external static pressures, in w.g.
 - 4) Fan suction static pressure, in w.g.
 - 5) Fan discharge static pressure, in w.g.
 - 6) Fan RPM
- h. Design and Actual Pressure Drops
 - 1) Across filter bank
 - 2) Across each heat transfer coil
 - 3) Provide complete pressure drop profile across each component in air handling unit
- i. Static pressure controls' identification (by service) and final setpoint.
- j. Evaluate building and room pressure conditions to determine adequate supply and return air proportions.
- k. Fan curves with actual operating conditions indicated.

2. Controllable Speed Fan with Variable Frequency Motor Speed Controller

- a. Establish the maximum speed setpoint by determining the following at maximum design air flow requirements:
 - 1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.
 - 2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
 - 3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.

- b. Establish the minimum speed setpoint by determining the following at minimum design air flow requirements:
 - 1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.
 - 2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
 - 3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.
 - c. Record the operating conditions of the controllable speed fan system(s) with variable frequency motor speed controller(s) at the time the preceding work is performed, including control settings, damper positions, filter conditions and other pertinent data, to permit duplication of all operating conditions during final calibration of the controllable speed fan variable frequency motor speed controller(s).
 - d. After final calibration of the fan controller(s) has been performed again duplicate all system operating conditions and repeat the balancing and adjusting work, specified above, to demonstrate the proper operation, control and calibration of each controllable speed fan system variable frequency motor speed controller at both minimum and maximum air flow conditions.
3. Air Flow Measuring Station
 - a. Fan or unit number
 - b. Station symbol and location
 - c. Manufacturer and model number
 - d. Design and actual velocity
 - e. Design and actual cfm
 4. Duct Velocity Traverse Data
 - a. Fan or Unit No.
 - b. Traverse location.
 - c. Design and actual CFM.
 - d. Duct dimensions and area.
 - e. Design and actual average velocity.
 - f. Duct static pressure at test holes, in. w.g.
 - g. Traverse measurements in FPM (show grid pattern).
 5. Air Volume Control Box Data
 - a. Unit symbol and location.
 - b. Manufacturer and model number.
 - c. Design and actual air velocity.
 - d. Design and actual CFM.
 6. Air Outlet and Inlet Data
 - a. Identify each outlet or inlet as to location, area and fan or unit system.
 - b. Manufacturer and model number.
 - c. Outlet or inlet size, effective area or Ak factor.

- d. Design and actual velocity, FPM.
- e. Design and actual CFM.

3.8 HYDRONIC SYSTEM BALANCING

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check expansion tank liquid level.
 - 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
- E. Set calibrated balancing valves, if installed, at calculated presettings.
- F. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- G. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- I. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
 - J. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
 - K. For variable flow systems, open or close sufficient valves to simulate design diversity, if applicable, and coordinate with BAS Contractor for setpoint and setting of all bypass valves.
 - L. For primary-secondary flow systems, first balance the primary system crossover flow, then balance the secondary system flow.

3.9 HYDRONIC BALANCING DATA

A. Include the following data in the TAB Reports:

1. Pump Data

- a. Identification and location.
- b. Service.
- c. Manufacturer, model, and serial number.
- d. Type drive.
- e. RPM.
- f. Rated and Actual Motor Data
 - 1) HP
 - 2) Phase
 - 3) Voltage
 - 4) Amperage
- g. Discharge and suction pressures and differential pressures (feet).
- h. Design and actual pump head (feet) and GPM.
- i. No flow (discharge valve closed) suction and discharge pressure (feet).

2. Equipment Data (air handling unit, chiller, terminal unit, radiation, coils, etc.)

- a. Identification (symbol) and location.
- b. Service.
- c. Manufacturer and, except for coils and radiation and the like, model, and serial number.
- d. Entering and leaving pressures and pressure differential (feet).
- e. Pressure differential across balancing valve (feet)
- f. Design and actual GPM.
- g. Entering and leaving water temperatures.

3. Flow Meter Data

- D. Record controller settings and note variances between set points and actual measurements.
- E. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- F. Check free travel and proper operation of control devices such as damper and valve operators.
- G. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- H. Check the interaction of electrically operated switch transducers.
- I. Check the interaction of interlock and lockout systems.
- J. For pneumatic control systems, check main control supply-air pressure and observe compressor and dryer operations.
- K. For electric control systems, record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
- L. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves
 - 2. Fan curves
 - 3. Manufacturers' test data
 - 4. Field test reports prepared by system and equipment installers
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page
 - 2. Name and address of TAB firm
 - 3. Project name
 - 4. Project location
 - 5. Architect's name and address
 - 6. Engineer's name and address

7. Contractor's name and address
 8. Report date
 9. Signature of TAB firm who certifies the report
 10. Table of Contents with the total number of pages defined for each section of the report
 11. Number each page in the report
 12. Summary of contents including the following:
 - a. Indicated versus final performance
 - b. Notable characteristics of systems
 - c. Description of system operation sequence if it varies from the Contract Documents
 13. Nomenclature sheets for each item of equipment.
 14. Data for terminal units, including manufacturer, type size, and fittings.
 15. Notes to explain why certain final data in the body of reports varies from indicated values.
 16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Variable speed controller settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Air System and Hydronic System Balancing Data:
1. Include all test data required for proper system balance and other test data specified elsewhere in this Section. Include all values, design and actual.
 2. Provide all duct traverse readings, including traverse locations marked on drawings.
- G. Vibration Measurement Reports:
1. Date and time of test.
 2. Vibration meter manufacturer, model number, and serial number.
 3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
 4. Diagram of equipment showing the vibration measurement locations.
 5. Measurement readings for each measurement location.
 6. Calculate isolator efficiency using measurements taken.
 7. Description of predominant vibration source.

H. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make
 - b. Serial number
 - c. Application
 - d. Dates of use
 - e. Dates of calibration

3.13 INSPECTIONS

- A. Periodically visit the site, as appropriate for size of project or as requested by Owner during the installation of the work. At a minimum, visit the site at the following times:
 1. After major equipment is set in place and rough-ins are completed.
 2. Prior to installation of shaft enclosures.
 3. Prior to ceiling installation.
- B. Should any potential or developing problems be discovered relating to accessibility, materials, equipment, or methods being used in the work, and where such problems may adversely affect the TAB work, immediately report these findings in writing to the Architect with recommendations for correction.
- C. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 1. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the setpoint.
 2. Walk through the spaces and observe any excessive noise or vibration from the HVAC system.
- D. Final Inspection:
 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, perform a final inspection to verify the following:
 - a. Verify that all balancing devices are marked with final balance position.
 - b. Verify that all holes in ductwork for pitot-tube traverse have been plugged.
 - c. Verify that all insulation removed during TAB work has been replaced.
 - d. Review requirements for follow-up seasonal checks and schedule dates with Owner.

END OF SECTION 01 91 00

SECTION 23 80 00 - HEAT TRANSFER

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:
 - 1. Unit heaters
- B. Related Sections:
 - 1. Reheat coils in air volume control boxes are specified with air volume control boxes in Division 23 "Ductwork and Ductwork Accessories".

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Enclosure joints, corner pieces, access doors, and other accessories.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Color Samples for Initial Selection: For units with factory-applied color finishes.
- D. Operation and Maintenance Data: For equipment include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of equipment and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."
- B. 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.

PART 2 - PRODUCTS

2.1 ELECTRIC CABINET UNIT HEATER

A. Acceptable Manufacturers:

1. Berko Electric
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.
5. QMark Electric Heating; a division of Marley Engineered Products.
6. Trane.

B. Unit arrangement as indicated. Electric finned tube heating element, double inlet centrifugal fans and motor, built-in thermal cutout switch, integral disconnect switch and temperature controls, bonderized 16-gauge steel casing and front panel finished in baked enamel, standard color as selected by Architect. Submit color chart.

C. Fans and direct driven motor mounted on common shaft and removable as a unit.

D. Unit shall be UL listed.

2.2 ELECTRIC WALL HEATER

A. Acceptable Manufacturers:

1. Marley Electric Heating Co. of "Q Mark".
2. Berko Electric
3. Electromode
4. Trane

B. Surface mounted, semirecessed, or fully recessed, wall mounted heavy duty type as indicated. Metal sheathing heating grid, safety switch, fan delay switch, integral thermostat, fan, oil sealed motor and "Heat-Off-Fan" selector switch.

C. Unit shall be UL listed.

PART 3 - EXECUTION

3.1 UNIT HEATER INSTALLATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install cabinet unit heaters to comply with NFPA 90A.

- C. Install propeller unit heaters level and plumb.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 80 00

SECTION 23 81 00 – UNITARY AIR CONDITIONING

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:

- 1. Packaged rooftop air handling unit.
- 2. Ductless split system air conditioning.

- B. Related Sections include:

- 1. Refrigerant piping systems are specified in Division 23 “Refrigerant Piping Systems”.
- 2. Cooling towers for water-cooled heat pump system are specified in Division 23 “Cooling Towers”.

1.3 DEFINITIONS

- A. RTU: Roof-top unit, also applies to packaged rooftop air handling unit.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer’s technical data for each manufactured piece of equipment, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Wind Loading Qualification Certification: Submit certification that equipment will withstand wind forces identified in Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

- F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. AHRI Compliance:

1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. UL Compliance: Comply with UL 1995.

E. 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.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components that fail in materials or workmanship within specified warranty period.

1.7 MANUFACTURER'S SUPERVISION AND INSPECTION SERVICES

- A. Refrigerant Piping System: Provide the services of the equipment manufacturer, or their authorized representative, to design and supervise the installation, cleaning and testing of the field installed refrigerant piping system. At the completion of the installation, the equipment manufacturer shall certify in writing that the installation was made in accordance with their design and recommendations and shall provide record fabrication drawing schematics showing all pipe sizes and specialties of complete refrigeration piping system.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. CaptiveAire Systems
2. AAON, Inc.
3. Carrier Corporation

4. Engineered Air
5. McQuay International
6. Trane
7. YORK International Corporation

B. General

1. Provide self-contained, packaged, factory assembled and prewired unit, consisting of cabinet and frame, and components as indicated.

C. Casing

1. Interior and exterior casing shall be constructed of minimum 24-gauge G90 galvanized steel and shall undergo salt spray corrosion test. Exterior walls shall be double-wall construction with 1-inch-thick, R4.3 fiber glass duct board insulation. Exterior casing shall include knockouts with grommet seals for electrical and piping connections and lifting lugs.
2. Base shall be constructed of minimum 18-gauge G-90 galvanized steel.
3. Roof shall be fabricated of double-standing, self-locking seam that requires no additional support. Roof shall be pitched to allow for proper drainage.

D. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.

E. Fans

1. Direct-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
2. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
3. Fan Motor: Comply with requirements in Division 23 Section "Electrical Requirements for HVAC Equipment."

F. Coils:

1. Supply-Air Refrigerant Coil:
 - a. Aluminum-plate fin mechanically bonded to copper tubes.
 - b. Coil Split: Interlaced.
 - c. Baked phenolic coating.
2. Outdoor-Air Refrigerant Coil:
 - a. Aluminum-plate fin mechanically bonded to copper tubes.
 - b. Baked phenolic coating.
3. Hot Gas Reheat Refrigerant Coil:
 - a. Aluminum-plate fin mechanically bonded to copper tubes.
 - b. Baked phenolic coating.
4. Electric-Resistance Heating:

- a. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- b. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
- c. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
- d. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - 1) Magnetic contactors
 - 2) SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - 3) Time-delay relay.
 - 4) Airflow proving switch.

G. Refrigerant Circuit Components:

- 1. Number of Refrigerant Circuits: One
- 2. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief and crankhouse heater.
- 3. Refrigeration Specialties:
 - a. Refrigerant Charge: R-410A
 - b. Expansion valve with replaceable thermostatic element.
 - c. Refrigerant filter/dryer.
 - d. Manual-reset high-pressure safety switch.
 - e. Automatic-reset low-pressure safety switch.
 - f. Minimum off-time relay.
 - g. Automatic-reset compressor motor thermal overload.
 - h. Brass service valves installed in compressor suction and liquid lines.

H. Air Filters

- 1. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
- 2. Pleated: MERV 8.

I. Dampers:

- 1. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with motorized damper filter.
- 2. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - a. Damper Motor: Modulating with adjustable minimum position.
 - b. Relief-Air Damper: Gravity actuated with bird screen and hood.

J. Electrical Power Connection:

1. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

K. Controls:

1. Basic Unit Controls:

- a. Control-voltage transformer.
- b. Wall-mounted thermostat or sensor with the following features:
 - 1) Heat-cool-off switch.
 - 2) Fan on-auto switch.
 - 3) Fan-speed switch.
 - 4) Automatic changeover.
 - 5) Adjustable deadband.
 - 6) Concealed setpoint.
 - 7) Concealed indication.
 - 8) Degree F indication.
 - 9) Unoccupied-period-override push button.
 - 10) Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.
- c. Wall-mounted humidistat or sensor with the following features:
 - 1) Concealed setpoint.
 - 2) Concealed indication.
- d. Remote Wall and Unit-Mounted Annunciator Panel for Each Unit:
 - 1) Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
 - 2) DDC controller or programmable timer and interface with HVAC instrumentation and control system.
 - 3) Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

2. DDC Controller

- a. Controller shall have volatile-memory backup.
- b. Safety Control Operation:
 - 1) Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit.
 - 2) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
- c. Scheduled Operation: Occupied and unoccupied periods on seven 365-day clock with a minimum of two programmable periods per day.
- d. Unoccupied Period:

- 1) Heating Setback: 10 deg F.
 - 2) Cooling Setback: System off.
 - 3) Override Operation: Two hours.
- e. Supply Fan Operation:
- 1) Occupied Periods: Run fan continuously.
 - 2) Unoccupied Periods: Cycle fan to maintain setback temperature.
- f. Refrigerant Circuit Operation:
- 1) Occupied Periods: Cycle or stage compressors and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - 2) Unoccupied Periods: Compressors off.
- g. Hot-Gas Reheat-Coil Operation:
- 1) Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
 - 2) Unoccupied Periods: Reheat not required.
- h. Electric-Heating-Coil Operation:
- 1) Occupied Periods: Cycle coil to maintain room temperature.
 - 2) Unoccupied Periods: Energize coil to maintain setback temperature.
- i. Fixed Minimum Outdoor-Air Damper Operation:
- 1) Kitchen Hood in Operation: Open to 100 percent.
 - 2) Kitchen Hood Not in Operation: Close the outdoor-air damper.
3. Interface Requirements for HVAC Instrumentation and Control System:
- a. Interface relay for scheduled operation.
 - b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - c. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - 1) Adjusting set points.
 - 2) Monitoring supply fan start, stop, and operation.
 - 3) Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
 - 4) Monitoring occupied and unoccupied operations.

L. Accessories

1. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.

2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
3. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
4. Coil guards of painted, galvanized-steel wire.
5. Hail guards of galvanized steel, painted to match casing.
6. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

M. Roof Curb:

1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1) Materials: ASTM C1071, Type I or II.
 - 2) Thickness: 2 inches.
 - b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - 1) Liner Adhesive: Comply with ASTM C916, Type I.
 - 2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - 3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - 4) Liner Adhesive: Comply with ASTM C916, Type I.
 - c. Curb Height: 14 inches.

2.2 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNIT

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. Sanyo
 2. Mitsubishi
 3. Enviromaster International
 4. Daikin
- B. Type: Provide ductless air conditioning systems complete with packaged wall mounted room unit, remote air cooled condensing unit (CU), temperature controls, filters, factory installed condensate pump, and other system components as specified or scheduled, all assembled and tested at factory prior to shipment.
- C. Wall Mounted Room Unit

1. Cabinet and Chassis: Constructed of 20-gauge galvanized steel and designed for easy installation and service access. Cabinet to have powder coat matte finish. Suitable wall mounting through setscrew mounting holes. Discharge grilles constructed of high temperature Noryl. Inlet grille to be steel.
 2. Refrigeration System: Split between indoor and outdoor sections. Both factory piped and sealed with an operating charge. Connection of the indoor and outdoor sections shall not require brazing, dehydration or charging.
 3. Evaporator Section: Copper-tube, aluminum-fin evaporator coil and thermal expansion valve. Provide condensate drain pan constructed of galvanized steel with anti-corrosion coating.
- D. Air Cooled Condensing Unit (CU): Hermetic compressor with overloads, manual reset high pressure switch, spring isolation, crankcase heater. Include filter drier, refrigerant line sight glass and moisture indicator. Condenser coil constructed of copper tubes and aluminum fins with direct drive propeller type fan. Capable of operation to -20°F. ambient air. Provide 24V control interconnection to evaporator unit.
- E. Air Distribution System: Direct drive fan assembly equipped with multiple, double-inlet blowers, self-aligning sleeve bearings and lifetime lubrication. Fan motor permanent-split, high efficiency type, equipped with two speeds for airflow modulation. Dehumidification shall utilize the lower fan speed.
- F. Air Filters: Permanent washable electrostatic type. Easily removable from front of unit and not require system shutdown for service.
- G. Controls: Factory assembled, wired into unit and tested prior to shipment. Consisting of an On/Off switch, adjustable temperature thermostat, high/low fan speed selector switch and indicator lights for fan speed and operational mode. Easily accessible from front of unit and protected by an impact resistant cover. Provide 24V remote thermostat with controls and relays.

PART 3 - EXECUTION

3.1 ALL EQUIPMENT WITH FILTERS

- A. Provide temporary filters for use during construction. Do not operate unit until filters (temporary or permanent) are in place. Replace all temporary filters used during construction with specified filters before turning equipment over to Owner. For air handling units, provide new clean filters as specified just prior to balancing work.

3.2 PACKAGED ROOFTOP AIR HANDLING UNIT INSTALLATION

- A. Examine roughing-in for rooftop units to verify actual locations of piping and duct connections before equipment installation. Examine roofs for suitable conditions where units will be installed.
- B. Prior to setting unit on roof curb, verify that area within curb is clean and dry. Ensure that all roofing work, insulation, acoustical treatment of roof deck, curb, etc has been completed as applicable. Provide full perimeter gasket around top of curb.

- C. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- D. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Ductwork and Ductwork Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.3 SPLIT SYSTEM AIR CONDITIONING UNIT INSTALLATION

- A. Install units level and plumb. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install roof-mounting compressor-condenser components on equipment support rails or curbs specified elsewhere in Division 23. Anchor units to supports with removable, cadmium-plated fasteners.
- C. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- E. Use qualified mechanics and thoroughly check equipment at site for leaks and loose connections in accordance with manufacturer's instructions.
- F. Install piping adjacent to unit to allow service and maintenance.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Provide manufacturer's certification of installation in accordance with requirements of Part 1 of this Section.

- B. Contractor shall be fully responsible for properly making arrangement for and coordinating with manufacturer to provide specified manufacturer's supervision and inspection services, and shall make any corrections or modifications to installation as required by the manufacturer.
- C. Tests and Inspections:
 - 1. After installing equipment and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 81 00

SECTION 26 05 00 - COMMON MATERIALS AND METHODS FOR ELECTRICAL

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 is intended to describe the basic materials and installation methods for electrical work; it applies in general to all Sections under DIVISION 26. All materials and equipment specified and/or shown on Drawings are new unless noted otherwise.
- B. All new materials, equipment and systems shall be listed and labeled by a licensed nationally recognized testing laboratory as defined by OSHA and used for the specific purpose, environment or application for which it was tested and approved. No field modifications and/or noncompliant installation whatsoever shall be made to any materials, equipment and systems that would violate the listing and labeling.
- C. This section includes the following:
 - 1. Electrical equipment coordination and installation
 - 2. Sleeves for raceways and cables
 - 3. Sleeve seals
 - 4. Grout
 - 5. Common electrical installation requirements

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

- E. Concealed, Exterior 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.
- F. EPDM: Ethylene-propylene-diene terpolymer rubber.
- G. NBR: Acrylonitrile-butadiene rubber.

1.4 REFERENCES

- A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:
 - 1. National Electrical Code, NFPA 70 (NEC)
 - 2. Underwriters' Laboratories, Inc. (UL)
 - 3. National Electrical Manufacturer's Association (NEMA)
 - 4. National Electrical Contractors Association (NECA)
 - 5. The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - 6. Applicable NFPA Codes and Standards
 - 7. See Drawing LS001 for a complete list of applicable codes
- B. Conflicts
 - 1. Nothing stated or shown in Specifications or on Drawings is intended to conflict with the above standards and regulations. Should Contractor find any apparent conflict, it shall be his responsibility to notify Architect before any of the work in question is performed or material purchased.

1.5 SUBMITTALS

- A. Provide Product List of factory fabricated items, in accordance with Section 016000 "Product Requirements", including name of proposed manufacturer, for all products specified in various sections of Division 26.
- B. Provide submittals in accordance with Section 013300 "Submittal Procedures" in sufficient detail to verify full compliance with the requirements of the Contract Documents.
- C. Product Data: Provide for each type of factory-fabricated product indicated.
- D. Submit testing reports.

1.6 WARRANTY AND CONTRACT CLOSEOUT

- A. Comply with warranty and contract closeout requirements specified in Division 01, GENERAL REQUIREMENTS.
- B. Provide Special Warranties and/or warranty service in accordance with Section 016000 "Product Requirements" where specified in the various sections of Division 26.

- C. Provide manufacturer's certificates of supervision and startup service as specified in the various sections of Division 26.
- D. Upon completion of work and tests, and at a time mutually agreed to by Contractor, Architect and Owner, operate all systems installed, in all parts, at Contractor's expense for sufficient length of time to demonstrate the mode of operation and definitely determine whether systems as a whole are in first class working condition. Defects and malfunctions that may develop during this period of operation shall be immediately corrected by Contractor at his own expense, and systems placed in first class working condition before being finally turned over to Owner.
- E. Include information for all products specified in the operation and maintenance manual.
- F. Provide electrical certificate(s) from electrical inspection agency - see Article titled "Inspections".
- G. Provide manufacturer's certification and warranty of system operation - see Article titled "Tests".

1.7 QUALITY ASSURANCE

- A. The specifications for certain products and alternative materials may appear in more than one section of Division 26. Work of Division 26 shall be coordinated for all sections of Division 26 to assure that where two or more items of any given product are furnished under Division 26 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 26.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle all material and equipment in accordance with manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.
- B. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.
- C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 PHASE ARRANGEMENT

- A. Exercise great care in maintaining a uniform and consistent arrangement of phase conductors on all systems. Throughout the entire wiring systems, each phase conductor must always be in the same physical position with respect to the other phase wires at equipment terminals.
- B. Identify phase wires by color coded conductors. Refer to Section 26 05 53.
- C. Determine the existing established phase arrangement and use it throughout the new addition and renovation. Use special care in determination and execution.

1.10 INSPECTIONS

- A. Before starting any Work under this Contract, file for inspection with the agency approved by the AHJ. Upon completion of the work, furnish electrical certificates from said agency for all electrical equipment and systems installed or furnished and installed as part of the work.
- B. Electrical equipment or systems that are modified in the field shall be reinspected. Furnish a new electrical certificate covering such modifications.

1.11 GENERAL COORDINATION.

- A. The electrical systems are indicated on the Electrical Drawings. Certain pertinent information and details required by the electrical work appear on the Architectural, Structural, Mechanical Civil, Fire Protection, and Low Voltage Drawings. Become familiar with all drawings and incorporate all pertinent requirements
- B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the Electrical work. Do not scale the drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.
- C. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.
- D. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.
- E. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- G. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- H. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.12 ELECTRICAL WORK ASSOCIATED WITH OTHER DIVISIONS

- A. WORK NOT REQUIRED BY DIVISION 26

1. Unless otherwise noted or specified, setting of mechanical equipment and associated safety and control devices will be done by Division 22 and 23 Contractors.
2. Control devices provided under Division 22 or 23 will include, but are not necessarily limited to the following:
 - a. Limit Switches: Aquastats, thermostats, air, gas and water pressure
 - b. Sensing Devices: Air, gas and water flow and their presence in atmosphere
 - c. Level Switches: Liquidometer, float switches or valves
 - d. Flow Switches: Air, medical gas, water
 - e. Proximity Switches: O.S.&Y. valve tamper
 - f. Valve Operators: Electric or air motors or pistons
3. Magnetic motor starters and their associated auxiliary contacts (other than Motor Control Center), pushbutton stations, selector switches, pilot lights and control switches that are integral with factory prewired packaged equipment.
4. Unless otherwise noted or specified, setting of mechanical equipment and associated safety and control devices will be done by Division 22 and 23 Contractors.
5. Reduced voltage and high voltage starters for chillers and other large motors indicated.
6. Automatic Temperature Control System including all necessary power wiring.
7. Integral disconnect switches for power roof ventilators.
8. Motors for mechanical equipment.
9. Vaporproof luminaires, including switches with pilot lights, conduit and wiring to a local junction box, for plenums of air handling units.
10. Variable frequency drives (VFD) and harmonic filters (optional) for chillers and other large mechanical equipment motors indicated.
11. Furnishing only of electric heaters as follows: unit heaters, cabinet unit heaters, baseboard heaters, duct heaters, radiant heaters and other heaters. Installation and wiring by electrical contractor.
12. Field wiring, other than power wiring, for electrical accessories furnished as an integral part of equipment furnished under Division 22 and 23.
13. Integral fused disconnect switch, circuit breaker or motor circuit breaker in control panels for Division 22 equipment, unless otherwise indicated.
14. Furnishing, installing and wiring of pilot switches, relays and other control devices required for the proper sequence, electrical or pneumatic control of the apparatus furnished under Division 22 and 23, and not specified or shown on Drawings as being furnished under Automatic Temperature Control System or under Division 26 of the Specifications.
15. Packaged room air conditioning units.
16. Variable frequency drives (VFD) furnished by Division 23 that are either integral with factory prewired packaged equipment or installed separately.
17. Passive communication cabling, terminations and devices are provided by Division 27.
18. Furnishing and installing heat trace cable and electric heaters in mechanical equipment, including control wiring.
19. Furnishing and installing humidifiers including control wiring.

B. WORK REQUIRED BY DIVISION 26

1. Provide all labor, materials, equipment, components and tools for required wiring and connections to control devices and instruments, as specified herein.
2. Provide all recording, indicating devices, contactors, time switches, photoelectric devices and lighting dimming equipment, as specified.

3. Install, completely wire and connect all systems specified herein in accordance with details on drawings and manufacturer's instructions.
4. Install and adjust all mechanical and electrical interlocks. Repair or replace faulty equipment.
5. Install, wire and connect electric heater non-integral thermostats.
6. Provide magnetic and manual motor starters for equipment furnished by others except where starters and controllers are furnished as an integral part of prewired packaged equipment.
7. Provide power wiring to starters and from starters to motor including all connections. Wire capacitors, VFD and associated filter when they are provided by Division 23. Exception: When motors, starters, controllers, etc., are furnished as an integral part of any equipment furnished under Division 23, only power wiring to power terminals on said equipment shall be included herein.
8. Provide Motor Starters including integral pushbuttons, pilot light, control switches, auxiliary contacts and the like, required for proper sequence and control function specified under Division 23.
9. Provide and wire all manual motor switches as required and specified.
10. Provide motor and circuit disconnect safety switches, both fusible and nonfusible types, as shown or as required by the NEC. Integral disconnect switches for power roof ventilators will be included under Division 23 and in equipment control panels under Division 22.
11. Provide branch circuits to ATC air compressor motor starters and associated air dryer. Branch circuits to ATC panels and other associated ATC equipment will be included under Division 25.
12. Provide branch circuits for pipe tracing electric heating cable, strip type space heaters, humidifiers and snow melting systems furnished and installed by Divisions 22 and 23.
13. Provide 120V circuits including conduit and wiring, to a junction box at air handling units. Make necessary connections to plenum luminaires, switches with pilot lights, receptacles and other 120V equipment.
14. Installation of electric unit heaters, cabinet unit heaters, baseboard heaters, and duct heaters including their power and control wiring.
15. Provide all interlock and control wiring shown or referred to on the Electrical and Mechanical Drawings.
16. Provide grounded convenience outlet, or grounded junction box for solid connection when required, for each electric water cooler. Locate properly so connection is not visible.
17. Installation of variable frequency drives (VFD). Exception: When furnished as an integral part of prewired packaged equipment. Provide power wiring to VFD and from VFD to motor including all connections. Obtain manufacturer's installation instructions and wiring diagrams from Division 22 and 23.

C. Plumbing, Gas and Fire Protection System Controls

1. All plumbing system control equipment and devices will be provided under Division 22, with the exception of Motor Control Centers and any devices so indicated or specified otherwise under Division 26.
2. The following controls will be furnished and installed by Division 22 Contractor and wired and connected by Division Contractor indicated:
 - a. Aquastats, float and pressure switches integral with a given system equipment piping
- Division 22 or Equipment Supplier; individual devices installed at construction site
-Division 26.

- b. Pressure switches, flow and OS&Y indicating valve switches for fire protection – Division 26. When these devices are installed concealed above ceiling construction, provide local space mounted condition pilot lights as indicated.
 - c. Control transformers for Plumbing and Fire Protection System if integral with equipment Division 21 or 22, respectively; otherwise - Division 26.
3. Coordinate all plumbing, gas and fire protection control equipment, devices, location of and test with the respective sections of Division 23.

D. Automatic Temperature Controls (ATC)

1. All temperature control equipment and devices will be provided under Division 25, with the exception of any devices indicated or specified otherwise under Division 26.
2. The following controls will be furnished and installed by Division 23, and as noted herein, wired and connected by Division Contractor indicated.
 - a. Line Voltage Thermostats – Division 25
 - b. Aquastats, Freezestats, Firestats – Division 25
 - c. Air Flow Switches, Float and Pressure Switches – Division 25
 - d. Pneumatic Electric (P.E.) and Electric Pneumatic (E.P.) Switches – Division 25
 - e. Duct Mounted Smoke Detectors - Furnished and wired to Fire Alarm System - Division 28. Installed and wired to dampers, fan controls and other mechanical devices – Division 25
 - f. Initiating Alarm Contacts for Supervisory (Surveillance) Alarm Wiring - Division 28.
 - g. Control Transformers for HVAC Control Equipment - Division 25; exception control transformers in Motor Control Centers provided under Division 26.
 - h. Selector Switches for indexing spare chilled and condenser water pumps to primary pump service - provided by Division 25, wired by Division 26
3. Coordinate all temperature control equipment device locations and test with the respective Division 23 Contractor.

E. Air Volume Control Box Wiring

1. Unless otherwise noted in the Panelboard Schedule, connect no more than ten (10) air volume control boxes on a 20A, 120V branch circuit.
2. Connect all air volume control boxes to the nearest normal 208/120V power panelboard within the respective electrical circuit zone, unless the air handler that serves the air volume control box is on emergency power and/or indicated in the air volume control box schedule shown on the mechanical drawings. Air volume control boxes requiring emergency power shall be connected to the nearest 208/120V emergency panel that is fed by the same automatic transfer switch (emergency branch) that supplies power to the respective air handler.
3. Refer to Mechanical Drawings for quantity and locations of air volume control boxes.

F. Smoke and Combination Fire/Smoke Damper Wiring

1. Unless otherwise noted in the Panelboard Schedule, connect no more than ten (10) smoke and/or combination fire/smoke dampers on a 20A, 120V dedicated branch circuit.

2. Connect all smoke and/or combination fire/smoke dampers to the nearest normal 208/120V power panelboard within the respective electrical circuit zone, unless the air handler that serves the smoke and/or combination fire/smoke damper is on emergency power. Smoke and/or combination fire/smoke dampers requiring emergency power shall be connected to the nearest 208/120V emergency panelboard that is fed by the same automatic transfer switch (emergency branch) that supplies power to the respective air handler. Circuits shall be arranged as follows:
 - a. Dampers located in riser shafts shall be circuited vertically to other dampers served by the same air handler.
 - b. Dampers located in areas, other than riser shafts shall be circuited horizontally to the nearest panel board (as described above) within the respective electrical circuit zone. Coordinate circuited arrangement with Division 23 contractor, prior to commencement of work, to limit the quantity of control relays associated with each fan.
3. Refer to mechanical drawings for quantity and locations of smoke and/or combination fire/smoke dampers.
4. Refer to detail titled "Shaft and Smoke Barrier Duct Smoke Damper Wiring Diagram" shown on the drawings for specific wiring requirements.

G. Kitchen Equipment Wiring

1. Provide all required branch circuits from panel to equipment rough-in location, and from rough-in location to attachment point on the equipment. Make all connections. Where branch circuits are shown turning up out of the floor, stub up 4 inches above finished floor and extend and make connections after equipment has been set in place and leveled by Kitchen Equipment Contractor. At wall or column locations, provide outlets and conduits in the wall whenever possible.
2. Kitchen Equipment Contractor will furnish all food service equipment completely wired internally. All electrical outlets and devices mounted on or in fabricated equipment will be provided by Kitchen Equipment Contractor, including internal wiring for same to a suitable terminal box, subpanel, starter or disconnect switch on equipment, except where receptacle symbols are shown, in which case install wiring and conduit to receptacle and make final connections.
3. Kitchen Equipment Contractor will provide Shop Drawings, including wiring and connection diagrams of all equipment to be used, and Roughing-in Drawings to locate all electrical work. Any deviation between these Shop Drawings and equipment provided shall be responsibility of Kitchen Equipment Contractor. Confirm all characteristics of each item of electrically operated equipment before installing wiring and circuit protective devices.
4. Electrically heated equipment will be provided by Kitchen Equipment Contractor with an "ON-OFF" light indicator, control, contactors, approved wiring, grounding, enclosure and equipment all connected to factory installed terminal boxes. For each voltage and phase requirement for a piece of equipment, there will be a one-point terminal box ready to receive final connection by Electrical Contractor.
5. All wiring shall be run concealed wherever possible. Provide all exposed conduit of EMT or rigid steel as required. Flexible conduit shall be liquidtight with appropriate fittings.
6. Lamp receptacles, raceways and lamps for equipment other than exhaust hoods will be provided by Kitchen Equipment Contractor when these items are an integral part of the

- equipment; provide connections to terminal box. Hood luminaires will be furnished by Kitchen Equipment Contractor; install and connect.
7. Exhaust hoods will be supplied and set in place by other trades, complete with luminaires, automatic washdown and dry chemical fire prevention system. For wiring of the washdown system, refer to schematic wiring diagrams supplied with the hoods.
 8. Provide wiring for automatic heat detectors so that upon activation of a detector the valve of the dry chemical bottle opens; the release microswitch on the gas supply solenoid valve shuts down the gas supply valve; closes all dampers; shuts down the exhaust fan; opens electrical power contactor or opens shunt trip circuit breaker and activates the building fire alarm system.
 9. Kitchen panelboard supplying cooking/frying appliances shall be provided with contactor(s) or shunt trip circuit breaker(s) which shall be interlocked to open required circuits when fire suppression system operates.
 10. Interconnect fire suppression system with the washdown system; main fire alarm system; hood exhaust system; electrical contractor/shunt trip circuit breaker devices and all items listed under paragraph 7.

H. Cooler and Freezer Wiring

1. Coolers and freezers will be supplied and installed by others, prewired complete with luminaires, light switch, door heater tape, all connected to a central terminal box. Provide required branch circuit wiring. Provide all conduit, wire and circuits required to operate refrigeration equipment, defrost heater, blower coil, alarm.
2. Arrange to have equipment supplier cut and seal all openings in coolers and freezers required to accommodate electrical system installation. Verify all locations with supplier.
3. Exposed conduit installed on surface inside coolers and freezers shall be installed parallel to room lines. Do not install exposed conduit if it can be avoided.
4. Where conduit enters refrigerated areas, install fiber nipple from box outside refrigerated area to surface mounted box inside area. Provide ground conductor through nipple. After conductors are installed, plug both ends of fiber nipple with oakum to prevent leakage and condensation.
5. Install required wiring and branch circuits when possible for blower fans, defrost heaters, lighting through top of cooler/freezer from surface mounted box in space above. Confirm characteristics of each electrical component before installing wiring and circuit protective devices, and provide as required.

I. Overhead Door Wiring

1. Install controller, push-buttons, limit switches, safety bars and key-operated stations for each overhead door. Provide branch circuit and control wiring, and circuit disconnect as required for each door.
2. Locate key-operated control station on the exterior of the building or where directed. Seal conduit after conductor installation.
3. Confirm all locations and electrical characteristics with supplier prior to installing electrical work.

J. Power Door Wiring

1. Perform the following work for power operated and power held doors furnished under other divisions of this specification.

2. Provide branch circuit/feeder and disconnect switches or devices at each location as shown or as required. Key switches if required will be furnished by others; install and connect.
3. Investigate and determine exact requirements for each power operated and held door specified or shown, for location of conduits, switches, controllers, etc., and type of connections. Coordinate all this data before making installation and provide as required to comply with manufacturer's requirements, details of installation and materials supplied. Wire and coordinate electric lock circuits for doors where required and/or indicated.
4. Certain doors to room(s) containing emergency engine generator(s) shall open automatically during operation of emergency engine generator and also open by operation of a local manual switch. Provide coordination and interwiring between the power door controller and engine generator control circuit relay contacts, for "open" and "close" response.

K. Electric Door Lock and Monitor Wiring

1. Perform the following work for the electric door lock and monitor systems specified and furnished under another section of this specification and as indicated.
2. Provide 120 Volt branch circuits required for each system specified, to a low voltage transformer and controller by others, as shown or required. Install and wire all electric door locks, contact devices, control switches and control devices for a complete operable system.
3. In addition to the local interior door systems, the following exterior doors with lock release system shall be equipped with a relay interwired with door security system circuit (specified by Division 28). When these doors are operated remotely, security status alarm will be bypassed (with time delay) during authorized door opening:
4. Investigate and determine exact requirements for each door lock system specified, for location of conduit, switches, wiring, etc., and type of connection, before installing any work and comply with manufacturer's requirements for details of installation and materials used.

L. Dock Leveler Wiring

1. Perform the following work for power operated dock leveler(s) provided under another division of this specification and as shown.
2. Provide branch circuit/feeder and disconnect switches or devices at each location as shown or as required, one at leveler control unit and one at the hydraulic pump unit.
3. Provide required control wiring, conduit and connections between control unit enclosure, manual and/or automatic operating switches, limit switches and power operators.
4. Investigate and determine exact characteristics for these units, for location of conduits, switches, controllers, etc., and type of connections. Coordinate all this work before installing same and comply with manufacturer's requirements, details of installation and materials used.

1.13 EQUIPMENT LOCATIONS

- A. Locations are subject to changes in order to avoid obstacles in building construction. Verify all dimensions and conditions at site. Check layout for sizes and clearances, so that the apparatus and material may be installed and operated satisfactorily in space provided. Install equipment and raceways to preserve headroom and to keep openings and passageways clear.

- B. Install equipment, boxes and outlets in accessible locations. Obtain final locations of all outlets and equipment from details on drawings and from Architect. Examine drawings of other trades and avoid interferences with their work.
- C. In case of conflict in location of flush outlets, architectural details shall take precedence.
- D. Install conduit to avoid mechanical and/or structural obstructions, minimizing crossovers.
- E. Install all exposed conduits parallel or perpendicular to building lines.
- F. Provide minimum of 6 inches clearance between electrical work and flues, steam pipes and other heat sources.
- G. Mounting heights of outlets and equipment shall be as indicated on "Mounting Height" Schedule, or as specified herein.
- H. Verify all door swings before installing switch boxes. In case of conflict between drawings, Architectural details shall take precedence.
- I. Architect reserves the right to change, without additional cost, location of any luminaire, wall switch, receptacle or power outlet, provided such changed location is not more than 10 feet, and is ordered changed before said work is completely "roughed in".
- J. Locations of electrical equipment and connections to all other equipment are approximately correct, and are subject to such modifications as are required at time of installation, in order to meet field conditions or the dimensions of equipment actually being supplied.
- K. No changes are to be made in the original design without written approval by Architect.

1.14 SEISMIC REQUIREMENTS

A. Seismic Design

1. All new electrical systems (equipment, tray and raceways) shall be provided with seismic restraints in accordance with the requirements of the applicable building code and site specific seismic design parameters considering exemptions where applicable.
2. Refer to Structural Drawings and Division 01 for seismic criteria to be used for this project.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.
- D. Coordinate sleeve selection and application with selection and application of fire stopping specified in Division 07 Section "Penetration Firestopping"

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc. (Inner Lynx)
 - b. Calpico, Inc. (Pipe Linx)
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc. (Link Seal)
 - e. O-Z/Gedney
- B. Description: Modular Sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel or stainless steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

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

2.4 CONDUIT SEALS

- A. All active and spare underground power and communication conduits greater than 1-1/4 inches, leaving manholes and entering building foundation walls and floor slabs shall be provided with an inflatable bladder as manufactured by Tyco-Raychem, Product No. RDSS. Refer to manufacturer's recommendations for bladder size and installation methods.

- B. All active and spare underground power and communication conduits 1 1/4 inch or less, leaving below grade enclosures and entering building foundation walls and floor slabs shall be sealed with an approved waterproof sealant.

2.5 FIRE-RATED CABLE PATHWAYS

- A. All telecommunications cable bundles shall utilize an enclosed fire-rated pathway device wherever said cables penetrate rated walls. The fire-rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. STI, Inc., EZ-Path (Basis of Design)
 - b. Hilti-Speed Sleeve
 - c. 3M
- B. Cable pathways shall have an orange finish color and dimensions per drawings.
- C. Provide three (3) cable pathways into each IDF, MDF and server room at the location of the cable tray penetration into each room. Provide "radius control module" on each end of cable pathway to provide a 1 inch minimum bend radius suitable for category as specified and fiber optic cables.
- D. Multiple cable pathways shall be installed in rated partitions utilizing manufacturer's recommended wall plate.
- E. Cable pathways shall meet or exceed rating of partition where pathway is installed. Refer to architectural drawings for rating of partitions.

2.6 INNERDUCT

- A. Description: Exterior and interior rated non-metallic and textile pathway used for the installation of outside plant (OSP) and inside plant (ISP) telecommunications cabling.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Non-metallic Flexible Innerduct
 - 1) Carlon (Basis of Design)
 - 2) Endot
 - 3) AT&T
 - b. Flexible Textile Fabric Innerduct

1) Maxcell (Basis of Design)

B. Non-metallic Flexible Innerduct

1. Innerduct shall be rated for use and spaced in accordance with NFPA 90A and NFPA 262 by UL Tested Method 910. Innerduct in return air ceiling shall be plenum rated.
2. Innerduct shall be constructed of corrugated high-density polyethylene and shall have a minimum inside diameter of one inch. Color shall be orange.
3. Innerduct shall be UL listed to UL2024 in accordance with NEC for plenum, riser, general purpose and other optical fiber cabling applications.
4. Innerduct and couplers shall be manufactured by the same company.
5. Innerduct shall be provided for each fiber riser and service cable from the point of origin to the termination location.
6. Spare Innerduct with nylon pull cord shall be provided in conduits and duct banks as indicated on the drawings and specified herein.
7. All Innerduct to have warning label at 4 feet on center. All terminations of Innerduct shall be mechanically connected to end component (cabinet, patch panel, enclosure, etc.) by appropriate mechanical fitting.
8. Refer to drawings for quantity and location of raceways requiring non-metallic flexible innerduct.

C. Flexible Textile Fabric Innerduct

1. General

- a. Material: White polyester and nylon resin polymer.
- b. Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the intended use.
- c. Flexible optical fiber/communication raceway.
- d. A non-metallic pathway, usually circular, placed within a larger non flexible raceway.

2. Description and Application

a. Outdoor Locations:

- 1) Detectable Outdoor Textile Innerduct Micro 2 inch, 3 inch and 4 inch single or multi-cell polyester/nylon textile innerduct containing 1,250 lb. polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19 AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.

b. Indoor - Non Plenum Areas

- 1) Indoor Textile Innerduct (Riser-listed): Micro 2 inch, 3 inch and 4 inch single or multi-cell nylon textile innerduct containing 1,250 lb. polyester flat woven pull tape which meets UL 2024A for flame propagation and smoke density values for general applications.

c. Indoor - Plenum Areas

- 1) Plenum-Listed Textile Innerduct: Micro 2 inch and 3 inch single or multi-cell nylon textile innerduct containing 200 lb. nylon-resin flat woven pull tape which meets UL 2024A for flame propagation and smoke density values for use in air handling spaces.
 - d. Refer to drawings for quantity and location of raceways requiring textile innerduct and diameter/number of cells per raceway.
3. Textile Innerduct Fittings
- a. Conduit Plugs: compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:
 - 1) 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
 - b. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
4. Pull Tape
- a. Measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.
5. Penetration Sealing Materials
- a. Duct Water Seal: Products suitable for closing underground and entrance conduit openings where innerduct or cable is installed to prevent entry of gases, liquids, or rodents into the structure.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. General

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.
6. Furnish, deliver, erect, connect and finish in every detail, all materials, equipment and accessories required for the Work. Select and arrange to fit properly into the building spaces.

7. Perform all work in accordance with the drawings, specifications, including manufacturer's installation instructions, all applicable codes and NECA's Standard of Installation guidelines.
8. Include in the Work and in the bid proposal minor details not shown or specified, but manifestly necessary for the proper installation and operation of the various systems, as if specified or shown.
9. Position and install all material and equipment to permit proper access and in such a manner that maintenance, adjustment, calibration, inspection, repair and replacement of the material and equipment can be accomplished with minimum effort and cost.
10. Perform the installation, wiring, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturers' instructions and recommendations. Such instructions and recommendations are hereby made a part of these Specifications.
11. If any departures from Contract Documents are deemed necessary, submit details of such departures and the reasons there for to Architect for approval.
12. Pull and junction boxes shall be located and sized by the electrical contractor in accordance with NEC, EIA/TIA, utility company requirements and/or owner standards, unless otherwise noted on the drawings.

B. Layout and Coordination

1. Lay out all work from approved building and property lines and benchmarks. Verify and be responsible for the correctness of all measurements in connection with work. Any change made in major overall dimensions as shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to the use of equipment of a manufacturer other than that used as the basis of design shall not cause any interference with other work.
2. Examine the drawings of other trades and initiate cooperation and coordination of the Work with the work of other trades to ensure that the Work can be installed properly as designed and planned without interference with other work or delay. Furnish all necessary templates, patterns, measurements, etc., for installing work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required by the Work may not be shown due to the small scale of the drawings; provide such offsets, bends or other items as required to meet structural or finish conditions.
4. Coordinate and be responsible for the required clearances of the Work in shafts, chases, double partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review space requirements that exceed those shown.
5. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
6. Install conduit, fittings, etc., to provide not less than 1/2 inch between their finished covering and the structure or adjacent work of any kind.
7. Electrical equipment shall not interfere in any way with other material or equipment and shall be provided with adequate working space; see the National Electrical Code working space requirements.

8. Make reasonable modifications in the layout of the Work, as directed, to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
9. Cooperate fully with the Contractor for General Construction in regards to location of electrical equipment and work progress schedules. Notify him of all flush panelboard locations so that wall of proper thickness is provided.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the Work is to be installed in relation to the work of other trades. Issue such drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades, detail and submit such deviation or conflicts to the Architect for review.
11. Locate wall switches at strike side of doors and at height indicated on "Mounting Height" schedule. Review all door swings with Contractor for General Construction prior to rough-in.
12. Locate receptacles at heights indicated in "Mounting Height" schedule. Mount receptacles vertically, ground pole at top. In special areas such as kitchens, laboratories, utility areas, coordinate locations with counters, benches and casework.
13. All devices and wiring are to be concealed where possible. Where specifically shown or where approved by the Architect, install exposed outlet boxes and branch circuit wiring in finished areas in formed metallic surface raceway systems using suitable factory fabricated fittings and devices as specified herein.
14. If work is installed before coordinating with all other trades and Owner's work, or so as to cause interference with the work of other trades, or so as not to provide proper access for maintenance or repair, make necessary changes in work to correct the condition at no cost to the Owner.

C. Excavation, Trenching, Backfilling

1. Mass excavation to required basic construction elevations will be performed under Division 31, EARTHWORK.
2. Provide all other excavation, trenching and backfilling including shoring, sheeting, pumping, grading, barricading and other related work necessary for installation of electrical work.
3. Perform work in accordance with the requirements of Division 31, EARTHWORK.

D. Cutting and Patching

1. Except where specified otherwise in Division 26, provide cutting, patching and refinishing work in accord with the requirements of Division 01, GENERAL REQUIREMENTS.
2. Horizontal chases shall not be cut into existing walls or partitions without approval of Architect.

E. Painting

1. Except where specified otherwise in Division 26, general painting will be provided under Division 09, FINISHES.
2. Touch up or paint out damage done to items having a factory applied finish, and which are installed under Division 26, utilizing materials and methods specified in Division 09. FINISHES.

F. Foundations

1. Provide concrete foundations required for the work specified under Division 26, unless specifically noted otherwise. Be responsible for preparing foundation drawings and setting foundation anchor bolts in time so as not to delay the work. Concrete foundations shall be of the types detailed or as specified.
2. Reinforce concrete foundations to suit the loads placed on them; foundations shall be in strict accordance with the equipment manufacturers' recommendations. Concrete materials and methods shall be as specified in Division 03, CONCRETE.
3. Unless otherwise indicated, concrete equipment pads shall be provided under all transformers and shall extend a minimum 4 inches above the finished floor, at least 4 inches beyond the equipment base in all directions, shall have the top edges and vertical corners chamfered and shall have the same surface finish as the adjacent and surrounding floor.
4. Securely anchor concrete foundations to the floor slab with steel dowels. When so indicated or where required, concrete foundations or concrete footings for structural steel supports for equipment too heavy to be placed in the floor slab shall be extended not less than 12 inches below the underside of the floor slab, except where bearing rock is encountered at a lesser depth. In such cases, after inspection and approval, concrete foundations may be set on bearing rock.
5. Furnish and set, with proper templates, anchor bolts leveling steel rails and inserts required for the proper attachment of the equipment to the concrete foundations. Anchor bolts shall be of the size and number required by the equipment or as recommended by the equipment manufacturer and shall be in accordance with the requirements detailed or specified. Anchor bolts shall also be compatible with vibration isolation requirements specified for the equipment.
6. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve shall be the same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, completely fill the annular space between the anchor bolt and the inside of the pipe sleeve for the full length of the pipe sleeve with Embeco, or equivalent, nonshrink cement grout.
7. Grout any openings between the top of the concrete foundation and the base of the equipment using nonshrink cement grout.
8. Piles, pile caps and foundation beams for exterior underground duct banks and for equipment foundations will be furnished under the General Construction Divisions of the Specifications.

G. Access Doors and Panels

1. Coordinate requirements for access panels and doors for electrical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
2. Furnish access panels required under Division 26 for installation under the General Construction Sections.
3. Furnish access panels for access to concealed junction/pull boxes, cabinets, terminal boxes and other equipment where other means of access is not available. Access panels shall be adequate in size for the service requirements, and shall not have a clear opening of less than 16 inches x 16 inches. Final size and location of access panels shall be subject to approval of the Architect. Cooperate with other trades so that the equipment will be accessible through the access panels.

H. Sleeves, Fire-stops and Waterseals

1. Provide each raceway or cable passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe with smooth edges, securely and neatly cemented in place. Provide each raceway or cable passing through a wood or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.
2. Set floor sleeves flush with floor surface in finished areas; 1 inch above the finished floor in kitchens, cafeterias and similar service areas, mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Wall and partition sleeves shall be flush with each surface unless otherwise indicated or specified.
3. Sleeves shall be 2 pipe sizes larger than the conduit or cable size unless otherwise required by the sealing method selected by the Contractor for Division 07, THERMAL AND MOISTURE PROTECTION. Coordinate with the Contractor for that section to determine requirements for sleeves, clearances, etc. Remove sleeve if required by UL listing for system selected.
4. Place sleeves in concrete floor or wall forms before concrete is poured. Sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.
5. Insure proper location and alignment of all sleeves for electrical work before and during concrete placement.
6. Where sleeves penetrate exterior walls, fill and seal ends around conduits and/or cables with duct sealant compound equal to Solorite KN-1146, or Link Seal. Install seals in accordance with the manufacturer's recommendations to provide airtightness above ground and hydrostatic sealing below grade. Caulking or other type mastic is not acceptable.
7. Provide fire-stop systems in accordance with Division 07, THERMAL AND MOISTURE PROTECTION.

I. Flashing and Counterflashing:

1. For conduit penetrating built-up roofing membranes, provide a flashing fitting located approximately 1 foot above the roof and extend the conduit to the required height. Flashing fitting shall be J. R. Smith 1750 or equivalent. For sizes when manufactured fittings are not available, the flashing fitting shall consist of a drilled and threaded standard cast iron or malleable iron cap, galvanized, one size larger than conduit and screwed to form a counterflashing or rainguard. Extend conduit through the cap and provide with a coupling for extension. Flashing under the Roofing Section will terminate at the flashing fitting. Apply two coats of asphalt base emulsion to the entire fitting and for a minimum of 6 inches up the conduit extension, to provide a completely weathertight installation.

3.2 PROTECTION OF WORK

- A. Protect all conduit, fittings, panelboards, switchgear, transformers and other equipment before and during installation and keep clean.
- B. Protect factory finished equipment, luminaires, panels, switchgear and devices with approved temporary protective material where these items are subject to accidental damage or abuse. Electrical equipment and switchgear shall be stored indoors or otherwise securely protected and kept free of condensation by adequate electric heat. Contractor shall remove all temporary protective material at the conclusion of the Work or as directed.

- C. The Contractor shall assume full responsibility for the cost of repairing or replacing any damaged Work or material caused by employees working under this Division.

3.3 TESTS

- A. Test equipment, including switchgear, motor starters, motors, panelboards and all other equipment to verify that items are free from unintended grounds, short circuits, and open circuits and that equipment will operate as specified. Test feeders for insulation resistance; for load balance of the final installation, and for overall operation of systems. Furnish labor and material required for making such tests and make corrections necessary to balance the load and to obtain proper operation.
- B. Measure secondary voltages after energizing transformers and adjust transformer taps to provide rated voltages listed on drawings and/or specifications. After building is in use, measure these voltages during a period of "normal load" and "light load". Report results to Architect, who will advise Contractor whether or not further adjustment of voltages is required. Make changes as directed.
- C. Test all wiring systems up to 600 volts, for insulation resistance with a megger in accordance with the NEC. Determine values with switchboards, panelboards, fuseholders, switches, receptacles and overcurrent devices in place.
- D. Determine ampere rating of thermal overload relays in motor starters and compare with equipment nameplate and actual current measurement of the motor. If overload relays are found to be incorrect, provide proper size. Provide proper motor rotation.
- E. Arrange for each system to be fully tested and adjusted by manufacturer or his authorized representative. Each element of each system shall be individually operated to insure that it will function as intended. Furnish all labor and material required to correct all defects.
- F. Submit to the Architect a letter from manufacturer (or authorized representative) of each system, attesting to the fact that all necessary tests and adjustments have been made and that the entire system is functioning properly in every respect.
- G. This article shall not be construed as deleting other tests specifically outlined in other sections of this Specification.

3.4 WORKMANSHIP

- A. Electrical equipment shall be installed in a neat and workmanlike manner in accordance with latest and best practices of the trade.
- B. Only mechanics skilled in this type of Work shall be employed and utilized by Contractor for this Division in the execution of this Work.

3.5 REFINISHING

- A. All surfaces of boxes, cabinets and equipment shall have suitable lacquer, enamel or plated finishes. Touch up any finishes marred during construction. Supports and other metal work not furnished with a protective coating, shall be given two coats of approved paint after completion of the work.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07, THERMAL AND MOISTURE PROTECTION.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07, THERMAL AND MOISTURE PROTECTION.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 INNERDUCT INSTALLATION

A. General

1. Provide innerduct for each fiber riser backbone cable as specified on the drawings.
2. All unused flexible non-metallic conduits shall be capped.
3. Innerduct quantity and diameter shall be as noted on the drawings.

B. Flexible Textile Fabric

1. Provide textile innerduct in conduit and wire ways and place textile innerduct within and under cable trays using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
2. Make a 2" incision approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape thus allowing the pull tape ends to retract back into the cells.
3. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.
4. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.
5. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
6. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
 - a. Design and install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
 - b. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.
 - c. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
 - 1) Plenum areas: Plenum-rated plastic or stainless steel

- 2) Non-plenum areas: Conventional flame-retardant nylon ties
- 3) Underground locations: Conventional plastic cable ties.

3.9 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07, THERMAL AND MOISTURE PROTECTION.
- B. Install all fire-rated cable pathways in accordance with manufacturer's recommendations.

3.10 CONTINUITY OF EXISTING SERVICES

- A. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for same, coordinate with Architect, Owner and other sections, and obtain prior written clearance from Owner. Provide and place notices in affected areas, and on luminaires or equipment, etc., which will be temporarily out of use. Remove notices when interruption has been completed.
- B. When Owner requires that work involving shutdown and interruption of existing facilities be performed on an overtime basis, Contractor shall pay all overtime costs.

3.11 DEMOLITION

- A. Disconnect and cap existing DIVISION 26 services to demolished areas of existing and new building(s) as required. Cap services at points where directed by Contractor for Division 2, EXISTING CONDITIONS. Contractor for Division 2 will remove abandoned DIVISION 26 services between capped services and demolished areas and will do all excavation and backfill in connection with disconnection and removal of the services.

3.12 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

- A. Make all necessary alterations to existing DIVISION 26 systems to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.
- B. Make all necessary alterations to existing DIVISION 26 systems to permit the installation of new DIVISION 23 equipment, i.e. ductwork and piping, to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.
- C. Where equipment, ductwork and piping is removed or disconnected under DIVISION 26, perform the work in such a manner that no damage is done to the structure or remaining portions of the systems.

- D. Remove exposed conduit, hangers and supports made obsolete due to this modification.
- E. Where existing concealed conduit is not to be reused, abandon same in place unless otherwise indicated or specified.
- F. Unless otherwise specified, all materials and equipment removed or disconnected by Contractor which are not to be reused shall become the property of Contractor and be removed from premises.
- G. Where excavation for new electrical work disturbs support of any existing underground services, materials, equipment and structures, provide new and suitable concrete, steel and brick supports as required. Review supports and supporting methods with Architect before beginning work.

3.13 COMMISSIONING

- A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".
- B. Ensure participation of major equipment manufacturers or their representatives.
- C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.
- D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 26 05 00

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related sections include the following:
 - 1. Division 26 Section "Common Material and Methods for Electrical"
 - 2. Division 26 Section "Identification for Electrical Systems"

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. NETA: International Electrical Testing Association.
- D. NRTL: Nationally Recognized Testing Laboratory.
- E. Homerun: The circuit conductors between the branch circuit outlet and/or device and the panel board over current protective device.
- F. VFD: Variable Frequency Drive or Variable Frequency motor Speed Controller (VFD)
- G. Wet Location: The interior of enclosures or raceways installed underground shall be considered to be a wet location.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. 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 location and application.
- C. Comply with NFPA 70.

1.7 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- B. Coordinate wall and floor penetrations with appropriate UL listed fire stopping systems.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. 600V Insulated Building Wire
 - a. Alpha Wire Corp.
 - b. General Cable Technologies Corporation
 - c. Southwire Company
 - d. Encore Wire Corporation
 - e. The Okonite Company
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Types THW-2, THHN-2-THWN-2, XHHW-2, and SO.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC
 - 4. 3M Company
 - 5. Ideal Industries, Inc.
 - 6. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, unless otherwise indicated.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in metal raceway or Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in metal raceway; Type XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Concrete and below Slabs-on-Grade: ; Type XHHW-2, Single conductors in raceway;
- E. Feeders in Wet Locations (See Definition in Article 1.3): Type XHHW-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in metal raceway; Type XHHW-2, single conductors in raceway.
- G. Normal Power and Lighting Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in metal raceway; Type XHHW-2, single conductors in raceway.

- H. Emergency Power and Lighting Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THHW-2, single conductors in metal raceway; Type XHHW-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete and Slabs-on-Grade: Type XHHW-2, single conductors in raceway.
- J. Branch Circuits in Wet Locations (See definition in Article 1.3): ; Type XHHW-2, single conductors in raceway.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- L. Class 1 Control Circuits: Type THHN-2-THWN-2, in raceway.
- M. Class 2 Control Circuits: Type THHN-2-THWN-2, single conductors in metal raceway or power-limited cable, concealed in building finishes
- N. VFD Output Circuits: Type XHHW-2, single conductors in metal raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Division 26, Section "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables through raceways.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- H. Where specifically shown or where approved by the Architect, install exposed branch circuit wiring in finished areas in formed metallic surface raceway systems using suitable factory fabricated fittings and devices as specified herein.
- I. Multi-wire branch circuits will not be allowed. A separate neutral conductor shall be provided for each branch circuit.

- J. The continuity of a neutral conductor shall not be dependent upon device and luminaire connections, where removal of such device would interrupt the continuity of circuit.
- K. All conductors of a parallel feeder shall be of the same length.
- L. Lace or clip groups of conductors at lighting and distribution panels, pull boxes and wireways.
- M. Where permitted install metal-clad cable per requirements of NEC and support at each junction box. Support only from building structure. Provide an additional three feet of cable at each luminaire and support excess cable only from structure; do not lay on ceiling tiles or attach to any other support systems.
- N. Protect metal-clad cable from physical damage where necessary by conduit, pipe, guard strips or other approved means.
- O. Where groups of armored and/or metal-clad cables extend from collector troughs, pull boxes or the like, secure and assemble them in an orderly manner on vertical cable tray or channel ladders.
- P. Not more than 4 armored and/or metal-clad cables shall be grouped or bundled together throughout the installation.
- Q. Insulated conductors and cables installed in underground enclosures or raceways shall be listed for use in wet locations and shall comply with NEC Article 310.10(C). Any connections or splices in an underground installation shall be approved for wet locations.
- R. Wireways and junction boxes shall not be used for routing and/or splicing of branch circuit, power and control wiring in excess of thirty current carrying conductors.
- S. Do not install conduits and cables in the cell of the metal deck above bar joists or other structural member.
- T. For branch circuits a maximum of six current carrying conductors shall be permitted to be installed in a raceway.
- U. The smallest size conductors permitted are:
 - 1. Lighting and Power Branch Circuits - No. 12 AWG
 - 2. Control Circuits - No. 14 AWG
 - 3. Luminaires (Pig Tails) - No. 16 AWG
 - 4. Fire Alarm System - No. 14 AWG
 - 5. Branch circuits rated 20 amperes, 120 volts and longer than 90 circuit feet from panelboard shall be #10 AWG.
 - 6. Branch circuits rated 20 amperes, 277 volts and longer than 150 circuit feet from panelboard shall be #10 AWG.

3.4 CONNECTIONS

- A. 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 and UL 486B.

- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color code conductors and cables according to Division 26, Section "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26, Section "Common Materials and Methods for Electrical"

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 26, Section "Common Materials and Methods for Electrical" and Division 7, Section "Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test all conductors and cables to verify that no short circuits or accidental grounds exist.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, per inspection and test procedures Section 7.3.2 as stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Cables will be considered defective if they do not pass tests and inspections. Perform corrective action, including replacement and retest.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding
 - 2. Common ground bonding with lightning protection system
 - 3. Panelboard bonding
 - 4. Fence Grounding

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells
 - 2. Ground rods
 - 3. Ground rings
 - 4. Grounding arrangements and connections for separately derived systems
 - 5. Grounding for sensitive electronic equipment
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

- b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. 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.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Equipment grounding conductor insulation color shall be continuous green, except for wire sizes No. 4 AWG and larger which shall be identified per NEC.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3
 - 2. Stranded Conductors: ASTM B8
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding and Grounding Conductor: Unless otherwise indicated on the drawings, use No. 4 or No. 6 AWG minimum, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- D. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn solid copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- E. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.
 - 1. Bury at least 24 inches below grade
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, connect horizontal buses with No. 4/0 AWG bare copper over doorway at right angles. Bond metal door frames to horizontal buses or No. 4/0 AWG conductor.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Exothermic-welding connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Compression or welded connectors.
4. Connections to Structural Steel: Exothermic-welding connectors.
5. Test Wells: Bolted connectors.
6. Connections to Fence posts and gates: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod and or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductor's level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Unless otherwise indicated, install minimum of four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bond concrete pad rebar to ground ring with tinned-copper conductor not less than No. 2 AWG. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated copper equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum unless indicated otherwise on the

drawings, insulated copper grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a grounding bus as indicated on the drawings and Specification Section 27 11 00.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in non-metallic conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least twenty (20) feet from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven in open bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductor(s), in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductor(s) to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas or other metal piping system downstream from equipment shutoff valve to the service equipment ground bus or grounding electrode bus.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column, at intermediate exterior columns at distances not more than 60 feet apart and at the column closet to the electrical service equipment or grounding electrode system.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building foundation.
- J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural

drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

- b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms
 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s)
 5. Substations and Pad-Mounted Equipment: 5 ohms
 6. Manhole Grounds: 10 ohms
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Hangers and supports for electrical equipment and systems
 - 2. Construction requirements for concrete bases

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. IMC: Intermediate metal conduit
- C. RMC: Rigid metal conduit

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems

- B. Shop Drawings: Signed and sealed by a qualified professional engineer in the corresponding state of the project location. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit
 - b. Cooper B-Line, Inc.; a division of Cooper Industries
 - c. ERICO International Corporation
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

8. Plastic Nylon Ties: Not acceptable.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: For horizontal pendent installation, install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits. For vertical surface installation, install steel slotted support system anchored to structural wall system for the entire length of run.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT REQUIREMENTS

- A. General
 1. Provide materials, equipment, supplies and labor necessary as required to adequately support, brace and strengthen all equipment and materials furnished as part of this work.
 2. Materials, equipment, apparatus supports and mounting hardware shall be approved for use in the location installed. For example, use electroplated galvanized, hot dipped galvanized, epoxy coated, PVC coated, stainless steel or aluminum in wet/outdoor locations.
- B. Attachment to Building Structure
 1. Light fixtures, raceways, boxes, cable trays, wireways, and other utilities shall not be supported by roof deck.

2. Light fixtures, raceways, boxes, cable trays, wireways may be suspended from floor deck provided the attachment is designed and supplied by the Contractor.
3. Transformers, switches, starters, apparatus, or any group of conduits in excess of 100 pounds shall not be supported by floor deck, regardless of concrete thickness above steel deck.
4. Transformers, switches, starters, apparatus, or any group of conduits in excess of 100 pounds shall not be suspended by concrete roof or floor slabs unless specifically shown on the contract drawings.
5. Whenever possible, support shall be provided directly to the main steel or concrete framing beams. If spacing of structure exceeds the spacing required to sufficiently support the electrical work, supplemental steel member or steel channel shall be designed and provided by the Contractor.
6. Support all Electrical work independently of any other trades. Under no circumstances shall work be supported or suspended from ceiling grids, ductwork, piping, or other supports for other trades.
7. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
8. Inserts in precast concrete to support Work of Division 26 will be furnished and installed by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.

3.3 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Install steel slotted channel-racks to finish wall anchored and fastened to structural floor and ceiling, and wall were crossing structural members. Anchor and fasten electrical items to the steel slotted support system. The steel slotted channel-racks shall be anchored and fastened by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Structural Steel: Beam clamps, angle clips welded or powder-driven studs.
 6. Exterior: Anchors, screws, bolts, etc., exposed to weather and corrosion shall be rustproof finished or nonferrous material.
 7. Adhesive Anchors: The use of adhesive anchors is prohibited.
 8. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or

- greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
9. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts and beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 10. To Light Steel: Sheet metal screws.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

- A. Unless otherwise indicated, construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. ENT: Electrical nonmetallic tubing
- C. EPDM: Ethylene-propylene-diene terpolymer rubber
- D. FMC: Flexible metal conduit
- E. IMC: Intermediate metal conduit
- F. LFMC: Liquidtight flexible metal conduit
- G. LFNC: Liquidtight flexible nonmetallic conduit
- H. NBR: Acrylonitrile-butadiene rubber
- I. RNC: Rigid nonmetallic conduit

1.4 SUBMITTALS

- A. Product Data: For surface raceways, conduits, wireways and fittings, boxes, enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes
 - b. Frame and cover design
 - c. Grounding details
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons
 - e. Joint details
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Structural members in the paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Qualification Data: For professional engineer and testing agency.
- E. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems, Inc.
 2. Alflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex
 7. Maverick Tube Corporation
 8. O-Z Gedney; a unit of General Signal
 9. Wheatland Tube Company
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.

- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit or IMC.
 - 1. Comply with NEMA RN 1
 - 2. Coating Thickness: 0.040 inch, minimum
- E. EMT: ANSI C80.3.
- F. FMC: Zinc-coated steel or aluminum.
- G. LFMC: Flexible steel conduit with PVC jacket.
- H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Fittings for EMT: Set-screw or compression type.
 - 2. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
 - 3. Fittings, couplings and connectors in general shall be of the same material as the conduit to which applied. Die cast fittings are not acceptable.
 - 4. Fittings and couplings for use with rigid and intermediate metal conduit shall be threaded type.
- I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose
 - 3. Arnco Corporation
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Heritage Plastics
 - 10. Lamson & Sessions; Carlon Electrical Products
 - 11. Manhattan/CDT/Cole-Flex
 - 12. RACO; a Hubbell Company
 - 13. Thomas & Betts Corporation
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.

- D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arco Corporation
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman
 - 3. Square D; Schneider Electric
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation
 - b. Walker Systems, Inc.; Wiremold Company (The)
 - c. Wiremold Company (The); Electrical Sales Division

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric
 3. Erickson Electrical Equipment Company
 4. Hoffman
 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
 6. O-Z/Gedney; a unit of General Signal
 7. RACO; a Hubbell Company
 8. Robroy Industries, Inc.; Enclosure Division
 9. Scott Fetzer Co.; Adalet Division
 10. Spring City Electrical Manufacturing Company
 11. Thomas & Betts Corporation
 12. Walker Systems, Inc.; Wiremold Company (The)
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary
- B. Interior Sheet Metal Outlet and Device Boxes: NEMA OS1.
1. General: Provide pressed galvanized sheet steel boxes with knockouts to suit raceway system to be used. Supports shall also be galvanized steel.
 2. Ceiling: Provide flush, 4 inch, octagonal boxes not less than 1-1/2 inches deep with 4 knockouts. Provide 3/8 inch luminaire studs where required. Surface, 4 inch, square boxes not less than 1-1/2 inches deep.
 3. Walls: Provide flush 4 inch boxes not less than 2 inches deep with matching plaster ring for single or 2 gang outlets. For larger boxes use 1-piece construction to suit application. In masonry use deep boxes with square corners so masonry units will fit closely to box.
 4. Do not use sectional or handy boxes unless specifically noted
- C. Exterior Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with threaded hubs sized for conduit to be used, deep type, covers fitted with gaskets.
- D. Communication Outlet and Device Boxes:
1. Unless noted otherwise, all communication outlet and devices boxes shall comply with paragraph titled "Sheet Metal Outlet and Device Boxes" above, except shall be 2-1/2 inches deep.
 2. Outlet boxes for "Swing Away Fiber Storage Kit"; provide 4-11/16 inch square by 4 inch deep backbox. Refer to specification 27 11 00 for storage kit requirements.
- E. Nonmetallic Outlet and Device Boxes: Not allowed.
- F. Metal Floor Boxes: Cast or sheet metal, rectangular.
- G. Nonmetallic Floor Boxes: Nonadjustable, round.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer in the state of the project location shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit or IMC, where applicable by Code
2. Concealed Conduit, Aboveground: Rigid steel conduit or IMC.
3. Underground Conduit for Lighting and Branch Circuits: RNC, Type EPC-Schedule A 40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed in Unfinished Areas, Not Subject to Physical Damage: EMT
2. Exposed in Unfinished Areas and Subject to Physical Damage: Rigid steel conduit or IMC. Includes raceways installed below 10 feet, in the following locations:
 - a. Loading dock
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units
 - c. Mechanical rooms
 - d. Boiler rooms
 - e. Garages
 - f. Warehouses
 - g. Tunnel
 - h. Shipping and receiving areas
3. Exposed in finished areas; Formed metallic surface raceway systems using suitable factory fabricated fittings and devices.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit or IMC.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. Use UL approved expansion fittings complete with grounding jumpers where conduits cross building expansion joints. Install bends or offsets in conduit adjacent to building expansion joints where conduit is installed above suspended ceilings.

3.2 RACEWAY INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.

- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, including walls of unfinished spaces, unless otherwise indicated.
- H. Raceways below slab on grade:
 - 1. Install RNC (Type EPC-40 PVC), rigid steel conduit or IMC.
 - 2. Before rising above the floor slab, conduit elbows and stub ups shall be RNC (Type EPC-80 PVC), rigid steel conduit or IMC.
 - 3. Conduits shall be located below the vapor barrier. Conduit penetrations through the vapor barrier shall be sealed in accordance with the barrier manufacturers recommendations.
 - 4. Conduits shall be located below the waterproofing and the penetration sealed with approved products that are part of the waterproofing system.
- I. Do not install conduits in concrete floor slabs unless shown otherwise.
 - 1. Maximum embedded conduit size shall be 1" nominal.
 - 2. Embedded conduit shall be galvanized rigid steel.
 - 3. Minimum center to center spacing of conduit shall be 6 inches. Conduit runs with multiple conduits spaced 6 inches on center must maintain that spacing until they exit the slab – reduced spacing between conduits as they approach the slab turn out will not be permitted.
 - 4. Embedded conduit shall be placed within the middle third of the concrete section. A maximum of two layers of conduits running in opposing directions shall be permitted within this section.
 - 5. A minimum of 1 inch of concrete shall be maintained between the face of rebar and the face of conduit.
 - 6. Embedded conduit will not be permitted in columns or shear walls, and at shear stud rail locations.
 - 7. Run conduits parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 9. The contractor shall produce layout, placement and fabrication drawings for all embedded conduit. The location of all conduits shall be dimensioned relative to column grid lines, slab edges and one another. Conduits shall be shown in section to demonstrate location within the depth of the slab. These drawings shall be submitted to engineer for review and approval as shop drawings. The Owner's testing and inspection agency shall review the field placement of embedded conduits against the approved shop drawings and shall certify that the conduits have been placed in accordance with the approved shop drawings. This certification shall be provided to owner and engineer prior to pouring concrete.
- J. Raceways Embedded in cast-in-place concrete Slabs

- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- N. Raceways for Optical Fiber and Communications Cable: Provide raceways, metallic and nonmetallic, rigid and flexible, as previously indicated herein with minimum size to be 1-inch (25mm) or larger as noted on drawings.
 - 1. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- P. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- Q. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- R. Flexible metal conduit shall be secured in place at intervals not exceeding 4-1/2 feet and within 12 inches of every outlet box, junction box, cabinet or fitting.
- S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- T. Set metal floor boxes level and flush with finished floor surface.
- U. Installation of conduit in exposed (areas without ceilings). Conduits shall follow building lines and shall be grouped to present a neat appearance. Conduit bodies (condulets) shall be used to accomplish the installation to keep the conduit as tight as possible to the structure. Diagonal runs of conduit is not permitted in exposed areas. Conduit shall be supported not more than eight feet on center regardless of size. Prior to installation of conduit systems Contractor shall provide layout drawings of conduit system for review by Architect.

3.3 BOX INSTALLATION

- A. Mount outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above removable ceilings. Secure firmly in place and set true and square with finished surfaces. Provide raised covers for boxes as required to suit the wall or ceiling, construction, and finish.
- B. Do not fasten boxes to ceiling support wires or other piping systems.
- C. Install pull and junction boxes above accessible ceilings and in unfinished areas only.
- D. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire. Note: Removable luminaires can only be considered an access point for pull and splice boxes (housing no active components nor devices requiring routine maintenance or repair).
- E. Locate flush mounted boxes in masonry walls so that only a corner need be cut from masonry units. Coordinate masonry cutting to achieve neat opening.
- F. Do not install flush mounted boxes back-to-back within the same wall; Install with minimum 6-inch separation. For acoustic rated walls, boxes shall be separated by at least one stud and a minimum 12-inch separation.
- G. Do not use two-gang and multi-gang boxes in such a manner that one section contains a switch or receptacle circuit or combination of such circuits operating at more than 277V.
- H. For boxes mounted in exterior walls install insulation behind outlet boxes to prevent condensation in boxes and air movement. Install boxes without damaging wall insulation or reducing its effectiveness.
- I. All boxes shall be provided with a far side support bracket to prevent movement.
- J. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.

- K. Support boxes independently of conduit.
- L. Install stamped steel bridges to fasten flush mounted outlet boxes between studs.
- M. Install adjustable steel channel fasteners for hung ceiling outlet boxes.
- N. Fire-resistance-rated walls and ceilings; Device outlet boxes shall only penetrate one face of a fire-resistance-rated assembly. Steel electrical boxes shall not exceed 16 square inches (i.e. a typical 4" x 4" outlet box), and the sum of such penetrations shall not exceed 100 square inches within 100 square feet of wall or ceiling space. Additionally, electrical boxes on opposite sides of the walls must either be separated by a distance of 24 inches, by a distance not less than the depth of a wall cavity when filled with insulation, by solid fireblocking, by listed putty pads, or by other approved listed materials and methods. Contractor can utilize a shallow (4" x 4" x 1 1/2") depth box to meet the above criteria if; volume of the box meets the minimum conductor fill requirements of the NEC and box is of sufficient depth to accommodate the device and terminations.

3.4 UNDERGROUND CONDUIT INSTALLATION

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
5. Warning Tape: Bury warning tapes approximately 12 inches above direct-buried conduits. Refer to Standard Details where applicable.

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND STRUCTURES FOR ELECTRICAL SYSTEMS

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. Conduit, ducts, and duct accessories for direct burial and concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants"

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for handholes, boxes, and other utility structures.
 - 4. Warning tape.
- B. Structural delegated design requirements
 - 1. The electrical contractor and the precast underground utility structure manufacturer shall provide calculation and drawing sealed by a structural engineer registered in the Commonwealth of Virginia for the design and installation of the precast handholes as follows:
 - a. Underground precast handholes shall be factory fabricated reinforced concrete, monolithically poured walls and bottom complying with ASTM C858 for design

and manufacturing process. Complete with accessories, hardware, and features as specified herein.

b. The calculation shall include as minimum:

- 1) Live load for units in roadways and other deliberate traffic paths in accordance with AASHTO HB 17, H-20 structural load rating.
- 2) Dead load of vertical and lateral components as determined by structural engineer.
- 3) Hydrostatic load based on water table elevation as provided by civil engineers.
- 4) The manufacturers engineer shall determine rebar size and spacing and length of anti-floatation collar. The collars can be either field or factory installed as determined by manufacturer's engineer.
- 5) Appropriate safety factor of 1.5 or larger shall be used.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes
2. Cover design
3. Grounding details
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. All drawings shall be submitted for review and approval prior to commencement of work.

E. Product Certificates: For concrete and steel used in precast handholes, as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical or Communication Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than fourteen days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of services without Construction Manager's and Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other new and existing utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings of same material as the conduit, complying with NEMA TC 3 and Type EPC-80-PVC and UL 514B.
- C. Fiber Glass Duct Elbows: NEMA TC 14, UL 2420, with straight end on deep socket PUC couplings. Heavy Wall Construction.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit.
 2. Carlon Electrical Products
 3. Cantex, Inc.
 4. CertainTeed Corp.; Pipe & Plastics Group
 5. IPEX Inc.
- B. Underground Plastic Utilities Duct: RNC, NEMA Type EPC-40-PVC and EPC-80-PVC with matching fittings, by the same manufacturer as the duct, complying with NEMA TC 9.
- C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 2. Warning Tape: Underground-line detectable warning tape specified in Division 26 Section "Identification for Electrical Systems."
 3. All active and spare underground power and communication ducts leaving handholes, entering building foundation walls and floor slabs shall be provided with an inflatable bladder as manufactured by Tyco-Raychem, Product No. RDSS. Refer to manufacturer's recommendations for bladder size and installation methods. Install at both the handhole and at entrance to building.

2.3 FIBER GLASS DUCT ELBOWS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Champion Fiberglass
 2. United Fiberglass
- B. Listing
1. The conduit shall be listed by UL, Underwriters Laboratories, to the UL 2420 Below Ground standard. All conduit shipped shall contain UL labels.
- C. Manufacturing
1. The conduit shall be fiberglass conduit, also known as Reinforced Thermosetting Resin Conduit (RTRC). All conduit shall be heavy wall construction. Tapering is only allowed at the belled end.
 2. The resin system shall be epoxy based, with no fillers. All additives for increasing flame spread and lowering smoke density shall be halogen free.
 3. Carbon black shall be used as ultraviolet inhibitor to protect the conduit and fittings during storage and exposure to the outdoors. Conduit and elbows shall be black in color.

4. The internal conduit and elbow walls shall be smooth and all fibers embedded in the epoxy.
5. All elbows shall meet the nominal radius + or - 2^o. The wall thickness shall meet tolerance as shown below and as shown in NEMA TC 14.

Conduit shall be manufactured with following nominal dimensions:

		Outside Diameter (inch)	Inside Diame- ter (inch)	Wall Thickness (inch)
4"	HW	4.512	4.320	.096
5"	HW	5.600	5.380	.110

Conduit shall be manufactured having non-tapered sections (except for integral belled ends).

6. All elbows shall have either straight ends or deep socket PVC couplings.
7. All conduits and elbows shall be durably and legibly marked in accordance to NEMA TC 14. In addition, the following information shall be included:

NEMA TC 14
 UL 2420 BG (Below Ground)
 Manufacturer and Reseller (if the conduit was modified or bent other than by the manufacturer)
 Date of Manufacturing of conduit and elbows
 Elbows shall be marked with the angle and radius

8. All conduit, elbows and fittings shall be manufactured in the U.S.A. and marked as such.
9. Electrical and Mechanical characteristics shall be per ASTM and API Standards

D. Manufacturer shall have a current Certificate, issued by an independent and accredited company, of compliance with an ISO 9001:2008 Quality Management System.

E. Joining System

1. The conduit shall be supplied with a gasketed joining system which can be used for concrete encasement as well as direct burial installations. This gasketed conduit shall consist of a three-ribbed gasket made from water resistant rubber material. The gasket shall be fit into a permanent groove in the belled end of the conduit. Retainer rings etc. are not permitted and shall not be used in order to create the gasket groove.

F. Toxicity

1. The conduit shall not contain any compounds that can release halogens, i.e. chlorine, bromine, flour and iodine in more than trace amounts when burning. Following shall be the maximum values when tested in accordance to ASTM E-800:

<u>Gases</u>	<u>Values (max p.p.m.)</u>
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Hydrogen Chloride	0
Hydrogen Bromide	0
Hydrogen Cyanide	<1
Hydrogen Sulfide	0
Ammonia	0
Aldehydes as HCHO	<10
Oxides of Nitrogen	<50
Carbon Dioxide	<12,500
Carbon Monoxide	<250

G. All Fiber Glass Elbows shall be fire resistant to UL 2515 specifications and shall be halogen free. Plastic duct plugs shall be manufactured from PVC.

H. Environmental

1. Manufacturer shall have a current Certificate, issued by an independent and accredited company, of compliance with an ISO 14001: Environmental Management Systems and Performance.

I. Installation Training

1. Manufacturer shall provide contractor installation training and certification for field cutting, joint preparation, joint assembly, field bending and RTRC field cut sealing (with field cutting sealant).

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AC Miller – Basis of Design
2. Oldcastle Precast Group
3. Utility Concrete Products, LLC
4. Utility Vault Co.

C. Comply with ASTM C 858 for design and manufacturing processes, with structural design loading as specified in Part-3, “Underground Enclosure Application” Article and with interlocking mating sections, complete accessories hardware and features.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC", "COMM."

4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 5. Anti-Floatation collar.
 6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 9. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with ANSI/SCTE 77 Latest addition.
1. Color: Gray, for other than in lawns. Green for lawn installations.
 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure with minimum rating of Tier 15.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Quazite
 - b. Armorcast Products Company
 - c. Carson Industries LLC
 - d. CDR Systems Corporation

2.6 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bilco Company (The)
 2. Campbell Foundry Company
 3. East Jordan Iron Works, Inc.
 4. McKinley Iron Works, Inc.
 5. Neenah Foundry Company
 6. Oldcastle Precast Group
 7. Osburn Associates, Inc.
 8. Pennsylvania Insert Corporation
 9. Riverton Concrete Products; a division of Cretex Companies, Inc.
 10. Utility Concrete Products, LLC
 11. Utility Vault Co.
- C. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated. This shall only be used when specifically noted on drawings.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated. This shall only be used when specifically noted on drawings.
- F. Underground Ducts Crossing Driveways, Roadways and Railroads: RNC, NEMA Type EPC-40-PVC, in concrete-encased.
- G. Contractor shall sprinkle the red dye mix on top of the wet concrete duct bank prior to concrete set up.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Underground-Line Detectable Warning Tape
 - 1. Description: Permanent bright-colored, continuous-printed polyethylene tape.
 - 2. Not less than 6 inches wide by 4 mils thick.
 - 3. Compounded for permanent direct-burial services.
 - 4. Provide with continuous metallic strip or core that shall be traceable type.
 - 5. Provided legend shall indicate type of underground service.
- E. Underground-Line Detectable Warning Tape: During backfilling of trenches, install continuous underground line tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench on concrete envelope exceeds 16 inches overall width. Space additional tapes 12 inches apart, horizontally.
- F. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic

pressure. Provide inflatable bladder at last handhole duct entering building and all duct penetrations into building.

H. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between handholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
6. Stub-Ups: Use manufactured fiberglass duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow. Protect stub-ups during construction.
7. Contractor shall sprinkle the red dye mix on top of wet concrete duct bank prior to concrete set up.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 30 inches below finished grade, unless otherwise indicated.
8. Install manufactured fiberglass conduit elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow. Protect stub-ups during construction.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line, below grade.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

C. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing or Thermoplastic Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.

- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- E. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of handholes. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Fire Alarm: White letters on red field.
 - 3. Communication Systems: Per vendor/owner requirements.
 - 4. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 - 3. At each service disconnect, provide plaque that denotes all other services, feeders, and branch circuits supplying the building and the areas they serve.

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT AND DEVICE IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength: 50 lb, minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 5. Mechanical and Electrical Supervisory System: Green and blue.
 6. Telecommunication System: Green and yellow.
 7. Control Wiring: Green and red.
- C. Emergency Systems: Each junction and pull box shall be painted orange. Use black indelible liquid marker to label "EMERG" in 3/8 inch letters minimum.

- D. Fire Alarm System: Each junction and pull box shall be painted Red. Use Black indelible liquid marker to label "FA" in 3/8 inch letters minimum.
- E. Feeders Shown on Single Line Diagram: Each junction and pull box shall be marked with black indelible liquid marker with the assigned feeder number (example: "FDR #3B) in 3/8 inch letters minimum.
- F. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- G. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape and write-on tags. Identify each ungrounded conductor according to source and circuit number. Each junction and pull box shall be marked with black indelible liquid marker with the assigned circuit number source panels and service voltage. (Example: 120V, AP-FL-B-1 CKT #14).
- H. Conductors to Be Extended in the Future: Attach write-on tags and marker tape to conductors and list source, service voltage and circuit number.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

L. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and Energy Storage.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

All switchboards, distribution panels and panelboards shall also indicate the name of the device or equipment where the power supply originates.

Example: Panel AP-1
 Fed from Substation SS-1

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Electrical substations.
- f. Emergency system boxes and enclosures.
- g. All other boxes and enclosures.
- h. Disconnect switches.
- i. Enclosed circuit breakers.
- j. Motor starters.
- k. Push-button stations.
- l. Power transfer equipment.
- m. Contactors.
- n. Remote-controlled switches, dimmer modules, and control devices.
- o. Battery inverter units.
- p. Battery racks.
- q. Power-generating units.
- r. Voice and data cable terminal equipment.

- s. Master clock and program equipment.
 - t. Television/audio components, racks, and controls.
 - u. Fire-alarm control panel and annunciators.
 - v. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
 - w. Monitoring and control equipment.
 - x. Uninterruptible power supply equipment.
 - y. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
3. Devices to be Labeled:
- a. Receptacles
 - 1) Normal Power Receptacles: Provide self-adhesive 3/8 inch high label with 3/16 inch high black lettering mounted at top of device cover plate.
 - 2) Wrap edges of self-adhesive label around edges of cover plate such that label is pressed between cover plate and wall.
 - 3) Lettering may be printed either on the back or front of label. Lettering shall be permanently affixed to label and resist damage from normal building operations.
 - 4) Label shall indicate branch circuit number and panelboard from which device is fed. Example: "A-1C-1 #2". Review nomenclature with the Owner.
4. Panel Schedule: For all new and/or altered existing panelboards, provide neatly typed Excel format panel schedules for each panel. Provide Owner with an electronic copy of Excel files for all panel schedules and post copy of each printed schedule on inside of panelboard door. Refer to 'Panelboards' Section 26 24 16 for additional requirements. Handwritten panel scheduels shall not be acceptable.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- J. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 26 05 53

SECTION 26 05 73 - ELECTRICAL SYSTEMS STUDIES AND ANALYSIS

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 computer-based, fault-current, arc flash hazard analysis and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Coordination of series-rated devices is permitted only where series ratings are allowed and indicated on Drawings and/or schedules.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: Submittal information shall be signed and sealed by a registered professional engineer (licensed in the State where project is located) indicating that the studies and analysis are in compliance with applicable codes and the requirements of this specification. Also refer to Section 1.4 "Quality Assurance" for qualification requirements.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Provide five (5) bound copies of complete final report and CD in PDF format.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
 - 4. One-Line Diagrams.
 - 5. Description, Purpose and Scope of the Study.
 - 6. PPE Ratings.
 - 7. Incident Energy and Flash Protection Boundary Calculations.
- E. Study: The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Engineer may be

obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory. Protective device coordination in regards to selective coordination is required prior to the applicable equipment review process.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional Electrical Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer. The Registered Professional Engineer shall be a full-time employee of the Engineering Services Organization.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with NFPA 70 and 70E.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
 - 1. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

- D. Computer software program capable of performing an Arch Flash Hazard Analysis in accordance with IEEE 1584 equations that are presented in NFPA 70E-2015, Annex D.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
 - 2. Maximum available fault current and impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - e. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.

- f. Time-current-characteristic curves of devices indicated to be coordinated.
- g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchboard bus.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard.
 - 4. Elevator controllers.
 - 5. Mechanical equipment starters/controllers
- B. Study electrical distribution system from normal power sources throughout electrical distribution system for Project.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10
 - b. ANSI C57.12.40
 - c. ANSI C57.12.22.
 - d. IEEE C57.96.
 - e. IEEE C57.12.00.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and ANSI C37.13.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5 cycle) and time delayed currents (6 cycles and above) on medium voltage breakers as needed to set relays and access the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit current.
- B. Comply with IEEE 14,1 IEEE 241, IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D.
- B. The short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model.
- C. The flash protection boundary and the incident energy shall be calculated at all significant new equipment locations in the electrical distribution system (transformers, switchboards, automatic transfer switches, distribution panelboards and panelboards) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all significant locations in 208-volt systems fed from transformers equal to or greater than 75 kVA.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual over current protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B1.2. The arc flash analysis shall be based on the lowest clearing time setting of the over current protective device to minimize the incident energy level without compromising selective coordination.

3.6 FIELD ADJUSTMENT

- A. Adjust protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Project Office in writing of any required major equipment modifications.
- D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a two-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.7 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location device analyzed.
- B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy range
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date.
 - 8. PPE Ratings/classification
- C. Labels shall be machine printed, with no field markings.
- D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 480 and applicable 208-volt panelboards, one arc flash label shall be provided.
 - 2. For each low voltage switchboard, one arc flash label shall be provided.
 - 3. For each distribution panelboard, one flash label shall be provided.
 - 4. For each panelboard, one flash label shall be provided.
- E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.8 ARC FLASH HAZARD TRAINING

- A. The equipment vendor shall train Owner’s personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 8 hours). Maintenance procedures in accordance

with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET). Provide the video of the training recorded on DVD to the Owner.

END OF SECTION 26 05 73

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Outdoor and indoor photoelectric switches.
 - 2. Indoor occupancy sensors.
 - 3. Lighting contactors.
 - 4. Emergency shunt relays.
 - 5. Wall box dimmers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
 - 2. Division 26 Section "Wiring Devices" for manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Occupancy Sensor Submittals
 - 1. Submit data sheets on sensors control modules, wiring diagrams and any related accessories.
 - 2. Submit shop drawings showing sensor layout and coverage pattern on floor plans. Layout shown on floor plans is based on Hubbell Building Automation.

3. Confirm finish of occupancy sensor during shop drawing submittal process, finish to be determined by Architect.

D. Occupancy Sensor Contract Close-Out

1. Provide operating instructions, maintenance manuals and warranty information to Owner.
2. Provide as-built drawings of sensor system wiring.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. 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.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lutron
 2. Lithonia Lighting; Acuity Lighting Group, Inc.
 3. Square D; Schneider Electric
 4. Eaton
 5. Watt Stopper (The)
 6. Hubbell
- B. Description: Solid state, with SPST or DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 2. Time Delay: 15-second minimum, to prevent false operation.

3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
- C. Description: Solid state, with SPST or DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 2. Time Delay: 30-second minimum, to prevent false operation.
 3. Lightning Arrester: Air-gap type.
 4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.2 INDOOR PHOTOELECTRIC SWITCHES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Lutron
 2. Eaton Electrical Inc; Cutler-Hammer Products
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Square D; Schneider Electric
 5. Watt Stopper (The)
- D. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.3 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements and basis of design, provide products by one of the following:
1. Hubbell Lighting (basis of design)
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Lutron
 5. Sensor Switch, Inc.
 6. Watt Stopper (The)
- B. Quality Assurance
1. The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry.
 2. Sensors and related relays shall be compatible with the specific lighting types controlled.
 3. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.
 4. All sensors and related equipment shall have a five-year warranty.
 5. All sensors and control modules connected to more than 50VAC shall be listed by Underwriters Laboratories.
 6. All sensors and related equipment shall be manufactured in the United States of America.
- C. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- D. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit. All sensors shall have selectable auto-on/auto-off and manual-on/auto-off operations.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
4. Occupancy sensors shown on floor plans are based on the following Hubbell catalogue numbers. Approved equal manufacturers must demonstrate equal coverage patterns and equal characteristics to the specified sensors.

Ceiling Mounted Dual Technology

	<u>Sensor Hubbell Cat. No</u>	<u>Application Area</u>
A..	OMNI-DT2000	1000 to 2000 sq.ft. area
B..	OMNI-DT1000	500 to 1000 sq.ft. area
C.	OMNI - DT500	Up to 500 sq.ft. area

5. Wall-switch sensors – Dual/Adaptive Technology
 - a. Single-relay: Hubbell Cat. No. LH-MTS1-HL; Two-relay/dual switch: Hubbell Cat. No. LH-MTD2-W.
 - b. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 1000 sq. ft.
6. Long-Range Wall-Switch Sensors:
 - a. Hubbell; LODT
 - b. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.
7. All ceiling mounted occupancy sensors, and long range wall-switch sensors require the use of a power supply, Hubbell Cat. No. MP-Power Pack or approved equal. Ceiling mounted occupancy sensors in rooms controlling 120V and 277V luminaires require an additional auxiliary relay, Hubbell Cat. No. MP-S auxiliary relay or approved equal. Contractor is responsible for field verification of required number of power packs:
 - a. One power pack is required for each circuit to be controlled
 - b. One Power pack is required for every three sensors in the zone.
 - c. If multiple circuits are to be controlled by a sensor, an auxiliary relay can be used in conjunction with the power pack.
 - d. The maximum number of sensors that can be put on a power pack is to be reduced by one for each slave pack used.
8. Where ceiling mounted occupancy sensors are provided, provide local wall switch for additional user control, to turn "off" lights when room is occupied.
9. Wall-mounted occupancy sensors shall have manual "on/off" override.

2.4 WALL BOX DIMMERS

- A. Manufacturers: Subject to compliance with requirements and basis of design, provide products by one of the following:
1. Lutron
 2. Hubbell
 3. Leviton
 4. Watt Stopper
 5. Acuity
 6. Eaton
- B. Controls
1. Performance
 - a. Dimmers shall provide full-range, continuously variable control of light intensity.
 - b. Controls shall fit a 1 inch wide, 1.5 inch tall wallplate opening with a vertical linear-slide. Controls shall be thin profile with no exposed heatsink/yoke. Unless otherwise specified, controls shall have a matte finish.
 - c. Controls shall provide a vertical slider allowing the light level or fan speed to be set by the user. Provide "preset" dimmers where the on/off function is independent of the dimmer slider position. This preset function shall be provided as a push on/push off switch integral to the slider knob and visibly distinct from the slider. For preset dimmers, when the lights are on, the slider shall change the light level and when the lights are off, the slider shall preselect the light level the lights will turn on to.
 - d. Control on/off function must be accomplished utilizing a mechanical air-gap switch to totally disconnect power from the load during "off" condition, no leakage current shall be present at the fixture(s).
 - e. Slider shall be captured behind wallplate.
 - f. Preset dimmers shall be capable of multi-location on and mechanical air-gap off using standard 3-way and 4-way switches.
 - g. Controls shall be able to have their visible plastic parts replaced, for color changes in the field, without removing the body of the control from the wall and without requiring special tools.
 - h. Within rated capacity, dimmers shall be available for direct control of incandescent, electronic low voltage, magnetic low voltage, and fluorescent.
 - i. Controls shall be capable of operating at the rated capacity; this includes modified capacities for ganging configurations which require the removal of fins. Operation at rated capacity shall be possible across the full ambient temperature range without shortening design lifetime.
 - j. Dimmer shall provide smooth and continuous Square Law dimming curve, for the full slider travel, on their rated load.
 - k. Controls shall meet the applicable requirements of UL 20 and UL 1472 referring to the inclusion of a visible, accessible air-gap off switch and the limited short circuit test.
 - l. Controls shall meet ANSI/IEEE Std. C62-41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.

- m. Dimmers shall be designed to reduce interference with radio, audio, and video equipment.
 - n. Controls shall incorporate power-failure memory. Should power be interrupted and subsequently returned, the lights or fans will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
 - o. Controls shall not be susceptible to damage or loss of memory due to static discharge.
 - p. Dimmer shall include voltage compensation to compensate light output for variation in the AC line-voltage. Dimmers in which the light output is not held constant with varying AC line-voltage shall not be acceptable.
 - q. Controls shall operate in an ambient temperature range of 0° C (32° F) to 40° C (104° F).
 - r. 3-way controls shall wire using conventional 3-way and 4-way wire runs.
 - s. Contractors shall install all backboxes with a minimum wallbox depth of 2.5 inches.
2. Electronic (Solid-State) Low Voltage (ELV) Transformer Dimmers.
- a. Dimmers shall contain circuitry specifically designed to control the input of electronic (solid state) low voltage transformers. Dimmers using standard phase control shall not be acceptable.
 - b. Provide ELV dimmers for direct control of up to 600 watts of electronic low voltage load.
 - c. Dimmers shall have a resettable overload protection that automatically shuts off when dimmer capacity is exceeded. Protection methods that are non-resettable or require the device to be removed from the wall to reset shall not be acceptable.
 - d. Dimmers shall be designed to withstand a short, per UL 1472 section 5.10, between load hot and either neutral or ground without damage to the dimmer.
 - e. Dimmers shall have a high-end of no less than 90% of line voltage.
3. Magnetic Low Voltage (MLV) Transformer Dimmers
- a. Provide MLV dimmers for direct control of up to 1500VA of 120 volt magnetic low voltage load.
 - b. Provide MLV dimmers for direct control of up to 1000VA of 277 volt magnetic low voltage load.
 - c. Dimmers shall contain circuitry specifically designed to control and provide a symmetrical AC waveform to the input of magnetic low voltage transformers per UL 1472 section 5.11.
 - d. Dimmers shall not cause a magnetic low voltage transformer to operate above the transformers rated operating current or temperature.
 - e. Dimmers shall have a 90% power limit to provide automatic energy savings and to extend lamp life.
 - f. Dimmer shall be capable of operating in either 3-way switch location.
4. LED Driver Dimmers
- a. Provide wall box dimmer compatible with LED driver.
 - b. Dimmer shall be designed to operate:

- 1) 3 wire driver
- 2) ELV driver
- 3) 0-10V driver
- 4) Addressable driver

5. Remote dimming modules for high power loads.

- a. Where lighting loads exceed the full rated capacity of single dimmers, provide a dimmer driving high power modules. High power module and dimmer shall be from the same manufacturer to ensure compatibility.
- b. High power modules shall be remotely mounted.
- c. High power module shall be rated and UL listed for control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and neon/cold cathode loads in increments of 2,000 watts up to 30,000 watts.

C. Wallplates

1. Wallplates shall be manufactured from durable polycarbonate plastic with matte finish, and shall attach to the basic components without using exposed hardware or screws.
2. Multigang wallplates shall provide a continuous, seamless cover for control and/or accessory combinations with no exposed hardware or screws. Custom wallplate configurations shall be available.
3. Multigang wallplates shall include snap in auto-align adapter plate for proper device alignment and wallplate attachment.
4. Control, accessory and wallplate profiles shall not exceed .30 inches from wall surface to faceplate front surface.

D. All dimming controls shall be 100% function tested at the time of manufacture. Stastical sampling plan shall not be acceptable.

2.5 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design, Inc.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. All sensor locations are approximate, refer to manufacturer's installation instructions prior to installation.
- C. Ceiling mount sensors should be located a minimum of six feet from HVAC supply/return vents.
- D. Contractor is responsible for: proper sensitivity and time delay settings (for nonadaptive products) recommended placement, and field verification within respect to power placement.
- E. Sensors mounted over the door must be placed one foot inside the threshold.
- F. Contractor is responsible for installing equipment in compliance with local code.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections in metallic junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Exposed cable splices, taps and terminations are not acceptable.

SECTION 26 09 36 - MODULAR DIMMING CONTROLS

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. Integrated, multi-preset modular dimming controls.
 - a. Low voltage wall stations
 - b. Control interfaces and modules
 - c. Occupancy, Vacancy, and Photocell Sensors
 - d. Emergency Lighting Control (if applicable)

1.3 REFERENCE STANDARDS

- A. ANSI C12.20 - American National Standards for Electricity Meters – 0.2 and 0.5 Accuracy Classes; 2010.
- B. ANSI C82.11 – American National Standard for Lamp Ballasts – High Frequency Fluorescent Lamp Ballasts – Supplements; 2011.
- C. ANSI/ESD S20.20 – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices); 2007.
- D. ASTM D4674 – Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments; 2002a (Reapproved 2010).
- E. IEC 60669-2-1 – Switches for Household and Similar Fixed Electrical Installations – Part 2-1: Particular Requirements – Electronic Switches; 2009.
- F. IEC 60929 – AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps – Performance Requirements; 2011.
- G. IEC 61000-4-2 – Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test; 2008.
- H. IEC 61000-4-5 - IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2008.

- I. IEC 61347-2-3 - Lamp Control Gear - Part 2-3: Particular Requirements for A.C. and/or D.C. Supplied Electronic Control Gear for Fluorescent Lamps; 2011.
- J. IEC 61347-2-13 - Lamp Control Gear - Part 2-13: Particular Requirements for D.C. or A.C. Supplied Electronic Control Gear for LED Modules; 2006.
- K. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).
- L. ISO 9001 - Quality Management Systems-Requirements; 2008.
- M. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- N. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.
- O. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- P. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- R. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- S. UL 508A - Industrial Control Panels; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- T. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- U. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- V. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- W. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.
- X. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

- C. Zone: A fixture or group of fixtures controlled simultaneously as a single entity.
- D. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- E. SCR: Silicon-controlled rectifier.

1.5 SUBMITTALS

- A. Product Data: For all products, including, but not limited to; multi preset modular dimming control; combined modular control systems; interfaces and devices; low voltage communications cabling; control devices, including, but not limited to; switches, sensors, dimming interface, wall plates, and conductors.
 - 1. Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.
 - 2. Project specific elevation, dimension, features, characteristics, ratings, and labels
 - 3. Device plates and plate color, material and finish.
 - 4. Required engraved switch labels and manufacturer engraving template.
 - 5. Required driver and LED combinations compatible with dimmers.
- B. Shop Drawings: Detailed assemblies of components, custom assembled for specific application on this project.
 - 1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required defining the installation, location, and configuration of all control devices. Indicate digital control loops on drawings.
 - 2. Provide room/area details including products and sequence of operation for each room, area, and/or networked system.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Include complete system wiring diagram illustrating all interconnections between components specified in this Section and devices furnished with power distribution system components required for building control. Include network cable specification and end-of-line termination details. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Coordinate nomenclature and presentation with room wiring diagram. Coordinate integration with mechanical and/or other trades.
 - 4. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
 - 5. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
- C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

- B. 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.
- C. Comply with NFPA 70 and meet all IECC 2015 energy code requirements.
- D. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- E. Installer & Commissioner Qualifications
 - 1. The system shall be commissioned by a company that has no less than 7 years of experience in the installation of digital lighting control systems. References shall be provided upon request. The system shall be installed by a company that has experience in deploying dimmable lighting systems. References shall be provided upon request.

1.7 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
 - 2. Coordinate lighting controls with ballast, drivers and dimmer type for all luminaires for a fully compatible system.
 - 3. Coordinate lighting controls with BAS either through IP based intercommunication of system or hardwired auxiliary relay outputs.
- B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.8 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.
 - 3. Lighting control system must be protected from dust during installation.

1.9 WARRANTY

- A. Provide a five year manufacturer's warranty on all hardware and software
- B. For drivers and ballasts, see section 265100 – Interior Lighting.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user.
- B. Make new replacement parts available for minimum of 10 years from date of manufacture.

PART 2 - PRODUCTS

2.1 GENERAL DIMMING DEVICE REQUIREMENTS

- A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts/drivers, transformers, and lighting controls. Dimming control components shall interface with all additional subordinate equipment.
- B. Dimmers and Dimmer Modules: Comply with UL 508.
 - 1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
 - 2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
 - 3. Control all light sources in a smooth continuous manner. Dimmers with visual stepping are not acceptable.
 - 4. Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.

2.2 MULTIPRESET MODULAR DIGITAL LIGHTING CONTROLS

- A. Basis-of-Design Product: Acuity nLight wired. Subject to compliance with requirements, provide product indicated on Drawings.
 - 1. Acceptable Manufacturers:
 - a. Cooper
 - b. Lutron
 - c. Wattstopper DLM
 - d. Hubbell
- B. Description: Modular digital lighting control system providing manual dimming control consisting of power (relay) packs controlled by wall stations, occupancy and / or vacancy sensors, daylight photosensors, and plug-load controllers. Wall stations shall be adjustable to indicated number of scenes and have color changing capabilities for RGBW fixtures within the space.
- C. Operation: System shall provide standalone lighting control zones for individual spaces. System shall be capable of utilizing room or circuit controllers, digital occupancy sensors, switches, daylight sensors, and accessories required by the lighting and or electrical system parameters.

System shall be capable of incorporating a network backbone for connection of multiple spaces and to allow for remote or time-based operation.

2.3 POWER PACKS AND ROOM CONTROLLERS

A. Description: Power packs and room controllers are individual control units or relays that can control single or multiple zones of luminaires. The control units can be connected to devices in the space wirelessly or via low voltage cable. The control units shall include the following features:

1. Power packs shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel

B. SWITCHING POWER PACKS AND ROOM CONTROLLERS

1. On/off control of lighting circuits through single or multiple relays.
 - a. Provide power packs and/or room controllers that are UL924 listed for switching and dimming of Emergency Power circuits. The unit shall provide normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored.
2. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button
3. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads

C. DIMMING POWER PACKS AND ROOM CONTROLLERS

1. On/off and dimming control of lighting circuits through single or multiple relays.
 - a. Provide power packs and/or room controllers that are UL924 listed for switching and dimming of Emergency Power circuits. The unit shall provide normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored.
2. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button

3. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads
4. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
 - b. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads
 - c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver
 - d. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim

2.4 WALL OR CEILING MOUNTED OCCUPANCY SENSORS

A. Quality Assurance

1. Sensors and related relays shall be compatible with the specific lighting types controlled.
2. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.
3. All sensors and related equipment shall have a five-year warranty.
4. All sensors and control modules connected to more than 50VAC shall be listed by Underwriters Laboratories.
5. All sensors and related equipment shall be manufactured in the United States of America.

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
 8. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 9. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
 10. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
- C. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit. All sensors shall have selectable auto-on/auto-off and manual-on/auto-off operations.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 300 sq. ft. when mounted on a 96-inch-high ceiling.
 4. Occupancy Sensing Capabilities
 - a. Occupancy sensors shall be configurable to control a local zone(s)
 - b. Multiple occupancy sensors shall be capable of controlling the same local zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
 - c. System shall support the following types of occupancy sensing sequence of operations:
 - 1) On/Off Occupancy Sensing
 - 2) Partial-On Occupancy Sensing
 - 3) Partial-Off Occupancy Sensing
 - 4) Vacancy Sensing (Manual-On / Automatic-Off)
 - d. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
 - 1) Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
 - 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
 - 3) To provide additional energy savings the system shall also be capable of combining Partial-Off and Full-Off operation by dimming the lights to a

- designated level when vacant and then turning the lights off completely after an additional amount of time.
- 4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage.
 - 5) The use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- e. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:
- 1) The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
 - 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
 - 3) To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
 - 4) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
 - 5) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage.
 - 6) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- f. To accommodate diverse types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.
5. All ceiling and wall mounted occupancy sensors shall be powered via Cat 5e or low voltage cables. When daisy chained using CAT-5e or connected wirelessly to other sensors, power packs, or switches, a lighting control zone is created.
 6. Where ceiling mounted occupancy sensors are provided, provide local wall switch for additional user control, to turn "off" lights when room is occupied.
 7. Wall-mounted occupancy sensors shall have manual "on/off" override.

D. Wired Occupancy and Photosensors

1. Product Series: nCM, nCMB, nRM, nWV, nHW
2. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
3. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
4. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
5. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
6. All sensing technologies shall be acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
8. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
9. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
10. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
11. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
12. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
13. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
14. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
15. Photosensor and dimming sensor’s set-point and dead band shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
16. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
17. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

2.5 DIGITAL WALL SWITCHES

A. Wired Wall Switches, Dimmers, Scene Controllers

1. Product Series: nPODM, nPODM xS, nPODM xL
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
5. Devices with mechanical pushbuttons shall provide tactile and LED user feedback.
6. Devices with mechanical pushbuttons shall be made available with custom button labeling.
7. Wall switches & dimmers shall support the following device options:
 - a. Number of control zones: 1, 2 or 4
 - b. Control Types Supported:
 - 1) On/Off
 - 2) On/Off/Dimming
 - 3) On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types
 - c. Colors: Ivory, White, Light Almond, Gray, Black, Red
8. Scene controllers shall support the following device options:
 - a. Number of scenes: 1, 2 or 4
 - b. Control Types Supported:
 - 1) On/Off
 - 2) On/Off/Dimming
 - 3) Preset Level Scene Type
 - 4) On/Off/Dimming/Preset Level for Correlated Color Temperature
 - 5) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
 - 6) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
 - c. Colors: Ivory, White, Light Almond, Gray, Black, Red

B. Wired Wall Switch Sensors

1. Product Series: nWSX LV
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

4. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
5. Devices with mechanical pushbuttons shall provide tactile user feedback.
6. Wall switches sensors shall support the following device options:
 - a. User Input Control Types Supported: On/Off or On/Off/Dimming
 - b. Occupancy Sensing Technology: PIR only or Dual Tech acoustic
 - c. Daylight Sensing Option: Inhibit Photosensor
 - d. Colors: Ivory, White, Light Almond, Gray, Black, Red

C. Wired Networked Power Packs and Secondary Packs

1. Product Series: nPP16, nPP16-ER, nPP20-PL, nSP16, nSP5-PCD, nSP5-2P-LVR, nSHADE, nAR40, nEPS-60, nPS-80
2. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
3. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
4. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.
5. Power Supplies shall provide system power only, but are not required to switch line voltage circuit.
6. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
7. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
8. Power Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
9. Power Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
10. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
11. Power/Secondary Packs shall be available with the following options:
 - a. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
 - b. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
 - c. Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
 - d. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.

- e. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
- f. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
- g. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
- h. Secondary Pack capable of louver/damper motor control for skylights.
- i. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
- j. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
- k. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

D. Wired Networked Bluetooth® Low Energy Programming Device

- 1. Product Series: nIO BT
- 2. Device shall be plenum rated and be inline wired, screw mountable.
- 3. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
- 4. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (*see list of available settings in section 2.4-System Software Interfaces, Sub-section E*).
 - a. Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

E. Wired Auxiliary Input / Output (I/O) Devices

- 1. Product Series: nIO-1S, nIO-RLX, nIO-MLO-5STEPA, nIO-MLO-AB, nIO-NLI, nIO-X, nIO-D, nIO-EZ-PH, nIO-EZD
- 2. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½” knockout.
- 3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
- 4. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
 - a. Contact closure or Pull High input
 - 1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
 - b. 0-10V analog input
 - 1) Input shall be programmable to function as a daylight sensor.
 - c. RS-232/RS-485 digital input

- 1) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
- d. dimming control output, capable of sinking up to 20mA of current
 - 1) Output shall be programmable to support all standard sequence of operations supported by system.
- e. Digital control output via EldoLED LEDcode communication
 - 1) Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

2.6 DMX COLOR CHANGING SYSTEM

1. Manufacturers

- a. Acceptable: Acuity Brands Lighting, Inc. – System: Acuity Controls
- b. Basis of controls design Manufacturer: Acuity Brands, One Lithonia Way, Conyers, GA 30012. The following may be acceptable with approval if compliant with this specification:
 - 1) Fresco Controls System

Substitutions: Not Permitted

2. General:

- a. Provide system hardware that is designed, tested, manufactured, warranted by a single manufacturer
- b. Operational Life: At least 10 years expected life while operating within the specified ambient temperature and humidity range
- c. Standards Compliance & Compatibility: Provide architectural control product with native DMX512-A control and BACnet/IP
- d. Luminaire Compatibility: Supports RGB luminaires in 8 bit and/or 16 bit configurations also supporting MSB or LSB first luminaire settings. Support native control of Tunable White luminaires.
- e. Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2 Level 4
- f. Power Failure Memory: automatically store system settings and recover from a power failure without requiring user input
- g. Wireless devices:
 - 1) Automatically sync for system operation without addressing
 - 2) Send and receive messages for real-time operation and feedback
 - 3) Use industry standard RF protocols
 - 4) Be in compliance with FCC and IEEE standards
- h. Time Clock: automatically adjust for daylight savings time and leap year

3. Dimming and Switching Performance Requirements:
 - a. Electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under full load
 - b. Inrush tolerance: Use MOSFET that has a maximum rating of six times the operating current of the dimmer/relay
 - c. Surge tolerance: Panels are designed and tested to withstand surges of 6,000V, 3,000A according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance
 - d. Power failure recovery: When power is interrupted and subsequently restored, within 3 seconds lighting to automatically return to same levels prior to power failure
 - e. Utilize half cycle to half cycle zero cross movement to allow for voltage compensation in order to overcome line noise and lamp flickering
 - f. Incorporate electronic soft start default at initial turn-on that smoothly ramps lights to appropriate levels within 0.5 seconds
 - g. Utilize air gap off to disconnect the load line from the line supply
 - h. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable
 - i. Assign load type to each dimmer that will provide proper dimming curve for the specific light source to be controlled
 - j. Minimum and maximum light levels are user adjustable on a circuit by circuit basis

4. Touch Panel Controls

- a. Product: Fresco Touch Screen (7TSN)
- b. Preset lighting scene controller
 - 1) General Requirements:
 - a) 7" full color multi-touch capacitive touchscreen for controlling lighting and system components
 - b) Control up to 65,000 zones of lighting/shades per system
 - c) Control up to 36 lighting channels/scenes per touch screen that include on/off, dimming, tunable white, RGB, and/or shade control
 - d) Link up to 24 touch screens for a possibility of 864 lighting zones/scenes
 - e) Connect up to 128 network devices per touch screen
 - f) On screen lighting design
 - g) Lighting zones/scenes can be comprised of lighting intensity, color, color temperature, and luminaire position
 - h) Modify color and color temperature using a digital color palette and dUV rating scale
 - i) Proximity screen sensor for auto "wake-up"
 - j) Auto dimming and user adjustable backlight
 - k) User programmable screen lock limiting access to all feature control and programming
 - l) Full alpha-numeric scene and zone naming
 - m) Configurable interface to reflect project requirements

- n) Lighting zones/scenes support control of forward/reverse phase dimming, 0-10v, RGB, nLight® enabled luminaires, nLight® power packs, DALI, tunable white and moving fixtures
- o) Integral astronomical time clock enables lighting scenes
- p) Partition status control and visualization
- q) Direct DMX control for a single universe (512 slots)
- r) Connect up to 128 nLight® enabled devices
- s) Digital daylight harvesting response
- t) RS-232/contact closure capable for 3rd party integration
- u) Local wireless Bluetooth connectivity with mobile app
- v) Compatible with Fresco Lighting Management Panels (LMP)
- w) Frame Color: Reviewed with architects on room-by-room basis.

2) Electrical:

- a) Fresco Input: 24VDC
- b) Fresco Power Supply: 120-277V AC
- c) RS-485 network terminal
- d) nLight enabled RJ-45 ports (in/out)
- e) CAT5e Ethernet network terminal
- f) DMX/RDM network terminal

3) Mounting:

- a) Installs in a standard triple gang US back box
- b) Remote mounted power supply
- c) Plug in wire harness for RS-485 and DMX connections

4) Protocols:

- a) RS-485
- b) IEEE 802.15 Bluetooth® compliant
- c) Controller is compliant to industry standard ANSI E1.11 - 2008, USITT DMX512-A
- d) Supports extended RDM capability as defined by ANSI E1.20
- e) IEEE 802.11 Ethernet compliant
- f) nLight Digital communication
- g) BACnet/IP ISO 16484-5

5. Mobile Control

- a. Fresco iPad Application
- b. Allows mobile control and programming of the Fresco Touchscreen (7TSN)

1) General Requirements:

- a) Mobile Apple device supports Bluetooth® communication protocol
- b) Provides user control and edit capability of lighting scenes and zones
- c) Edit intensity, color, color temperature, and movement
- d) Edit lighting schedules
- e) Restrict number of users able to connect to touchscreen

- f) Restrict access to making system changes
- g) No PC required for mobile operation

6. Device Quality

- a. Perform 100% function testing of all devices

2.7 WALL BOX ACCESSORIES

A. Wall Plates

- 1. Listed to UL 514C, CSA C22.2 #42.1-00
- 2. Provide an adapter plate for proper device alignment and wall plate attachment.

2.8 SOURCE QUALITY CONTROL

- A. Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

2.9 CONDUCTORS AND CABLES

- A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors shall be as required by the equipment manufacturer. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. CAT 5e Cable: Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors. Pre-terminated Cat 5e cables with RJ-45 connectors. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable. If manufacturer's pre-terminated Cat 5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.

- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's installation instructions.
- B. Provide complete installation of system in accordance with Contract Documents.
- C. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- D. Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.
- E. Mount exterior daylight sensors to point due north with constant view of daylight.
- F. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

3.3 STARTUP SERVICE AND SUPPORT

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.
- B. Engage a factory-authorized service representative to perform startup service. Owner's Representative and Architect shall be notified when startup service visits are scheduled and completed.
 - 1. Complete initial review meeting with construction team and commissioning agent to review installation techniques, project specific wiring requirements, and product information prior to installation of equipment.
 - 2. Complete pre-wire installation and startup checks according to manufacturer's written instructions.
 - 3. Activate light fixtures and verify that all lamps are operating at 100 percent and dimming is functioning.
 - 4. Confirm correct communications wiring, initiate communications between devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
 - 5. Establish lighting levels for all rooms per sequence of operations.
 - 6. Calibrate all photo cells to appropriate lighting levels.
 - 7. Program all low voltage end devices and test to meet sequence of operation and owner requirements.

3.4 STARTUP AND PROGRAMMING

- A. Provide factory certified field service engineer to complete all onsite tasks and start up requirements as indicated for all luminaires and components. Quantity of days on site shall be provided as required for a complete fully functioning start up. Coordinate testing and demonstration of products specified in this section with testing and demonstration requirements for low voltage, programmable lighting control system specified in Division 26 Section “Modular Dimming Controls”. Technician shall be on site a minimum of 2 days to ensure proper system installation and operation under following parameters:
1. Qualifications for factory certified service engineer:
 - a. Minimum experience of 2 years training in the electrical/electronic field.
 - b. Minimum of 5 installations with the specific lighting control system.
 - c. Certified by the equipment manufacturer on the system installed.
 - d. Visit duration shall be suitable to accomplish required tasks.
 - B. First Visit Task: Make visit(s) to the site prior to installation of wiring. Meeting shall include initial review with the construction team to review installation techniques and product information. Meeting shall include start-up checks in accordance with manufacturer’s written instruction.
 - C. Second Visit Task: Make visits upon completion of installation of Network Lighting Control System. Visits shall include field testing of lighting control equipment in accordance with manufacturer testing procedure. Coordinate field testing inspections with commissioning agent.
 1. Review:
 - a. Verify all luminaires are installed and active, and operate at 100% light output.
 - b. Verify connection and location of controls.
 - c. Verify system operation control by control.
 - d. Configure initial groupings of led drivers for wall controls, daylight sensors and occupant sensors.
 - e. Initial calibration of sensors and setting of photocell to maintain indicated illuminance levels in all spaces.
 - f. Obtain sign-off on system functions.
 - g. Verify proper orientation of manufacturers interfacing equipment.
 - D. Third Visit Task:
 1. Tuning
 - a. Lighting control system manufacturers shall coordinate on-site meetings with owner and architect to make required lighting adjustments to the system for conformance with the design intent, and preset/zone requirements determined in review with the architect/owner and manufacturer prior to programming. At the completion of the tuning site visits and when all associated adjustments to the system have been completed and tested, the manufacturer shall complete final inspection of the system.

2. Adjustment/Training

- a. Engage a factory-authorized service representative on site to train owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface. Provide a minimum of one complete training session to be scheduled with owner personnel.
- b. The end customer shall be trained in the usage of the system within 1 month of completion of the startup process.

3.5 CLOSEOUT ACTIVITIES

- A. System Optimization Visit: Lighting control system manufacturer shall provide a factory certified field service engineer on site within 6 months after completion of the final construction phase to evaluate system usage and make adjustments at the direction of the owner.

3.6 MAINTENANCE

- A. Capable of providing on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

END OF SECTION 26 09 36

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

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 types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. 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.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ACME Electric Corporation; Power Distribution Products Division
 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 3. Eaton Electrical Inc.; Cutler-Hammer Products
 4. General Electric Company
 5. Magnetek Power Electronics Group
 6. Siemens Energy & Automation, Inc.
 7. Sola/Hevi-Duty
 8. Square D; Schneider Electric

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilating, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Manufacturer's standard.
- E. Taps for Transformers Smaller Than 3 kVA: None.
- F. Taps for Transformers 3 to 15 kVA: Two 5 percent taps below rated voltage.
- G. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Transformers shall meet DOE Energy Efficiency Standards (DOE 10CFR Part 431 Energy Conservation Standards). Transformers shall be provided with DOE 2016 efficiency levels at 50% load.
- J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- K. Wall Brackets: Manufacturer's standard brackets.
- L. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 40 dBA
 2. 30 to 50 kVA: 45 dBA
 3. 51 to 150 kVA: 50 dBA
 4. 151 to 300 kVA: 55 dBA
 5. 301 to 500 kVA: 60 dBA
 6. 501 to 750 kVA: 62 dBA
 7. 751 to 1000 kVA: 64 dBA

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution and buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

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. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards
3. Load centers
4. Electronic-grade panelboards

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating
- B. SPD: Surge protective device

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.

- D. Field Quality-Control Reports:
 - 1. Test procedures used
 - 2. Test results that comply with requirements
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Provide electronic files in Excel format to Owner. See section titled "Identification of Electrical Systems" for additional requirements.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments
- G. Total Energy Use: Summation of total energy use broken down by component and expressed in terms of total connected power and expected daily power use.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

- B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1
 - b. Outdoor Locations: NEMA 250, Type 3R
 - c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12
 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 3. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 1. Material: Tin-plated aluminum.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 4. Split Bus: Vertical buses divided into individual vertical sections.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
 2. Main and Neutral Lugs: Mechanical or compression type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical or compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical or compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical or compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals, as noted in panelboard schedule.
- I. Panelboard Suppressors: As noted on Drawings and in Division 26 Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits". Provide as indicated and specified in Section 26 43 13.
- J. Selective Coordination: Comply with NFPA 70 and Owner's requirements as indicated.

2.2 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product name or comparable product by one of the following:
1. Square D "I-Line Series"; a brand of Schneider Electric (Basis of Design)
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or lugs only as indicated on Drawings and/or Schedules
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or jaw type plug-on.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or jaw type plug-on.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - 1. Square D; a brand of Schneider Electric (Basis of Design)
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only as indicated on drawings and/or schedules
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product name or comparable product by one of the following:
 - 1. Square D; a brand of Schneider Electric (Basis of Design)
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted, universal-mounted, integral or din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 9. HACR Circuit Breakers: Single, two, and three-pole configurations rated for protection of heating, air conditioning and refrigeration equipment.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.
- C. Contractor shall provide all lugs required for cable sizes shown on single line diagrams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Install panelboards on structural channel framing.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from each flush mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future. Where applicable, stub four 1-inch empty conduits into raised floor space.

- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Refer to section titled "Identification for Electrical Systems" for additional requirements.
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
- b. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Electrical Systems Studies and Analysis."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

- 1. Measure as directed during period of normal system loading.
- 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
- 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
- 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 COMMISSIONING

A. Coordinate commissioning and start-up with overall electrical power monitoring and control system specified in Section 26 09 13.

- B. Factory trained technician shall review connections and setup devices, addresses and metering parameters.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Snap switches and wall-box dimmers.
 - 4. Solid-state fan speed controls.
 - 5. Communications outlets.
 - 6. Cord and plug sets.
 - 7. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for indoor and outdoor occupancy sensors, and wall box dimmers.
 - 2. Division 27 Section "Communications Horizontal Cabling" for work station outlets.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. 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.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Eaton Wiring Devices/Arrow Hart.
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1877 (single), 5362 (duplex).
 - b. Hubbell; HBL5351 (single), CR5362 (duplex).
 - c. Leviton; 5891 (single), PS5362 (duplex).
 - d. Pass & Seymour; 5381 (single), 5362 (duplex).
- B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; TR5362.
 - b. Hubbell; TR5362.
 - c. Leviton; TCR20.
 - d. Pass & Seymour; TR5362.
- C. USB Charger, Tamper Resistant, Duplex Convenience Receptacles, 125 V, 20 A with two USB Type A, Class 2.0 ports, 3.1 A minimum, 5 Volt DC: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; TR7756
 - b. Hubbell; USB20X2
 - c. Leviton; T5832
 - d. Pass & Seymour; TR5362USB
- D. Receptacles located in damp or wet locations shall be listed weather-resistant (WR) type.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI (Self Test) Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; SGF20.
 - b. Pass & Seymour; 2084.
 - c. Hubbell
 - d. Leviton
- C. Receptacles located in damp or wet locations shall be listed weather-resistant (WR) type.

2.4 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; AHL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.5 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

- d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour
 - e. r; PS20AC1-PLR for 120 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1995L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton/Arrow Hart; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.
- G. "E" Designated Switches: Switches used for emergency lighting shall be lighted hand type (lighted when load is off) with Red Lexan handle.
- H. "RP" Designated Switches shall be corrosion, moisture and dust resistant assemblies made of yellow neoprene 20 ampere, 277/120 volt.

2.8 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: To be selected by Architect.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with "Extra Duty" type 3R. Metal low profile, expandable from 2-1/2" to 4-1/2" rain-tight while in use with lockable cover as manufactured by TayMac or equal. Finish color to be selected by Architect.

2.9 MULTIOUTLET ASSEMBLIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems
 - 2. Wiremold Company (The)
- C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- D. Raceway Material: Metal, with manufacturer's standard finish options. Finish color to be selected by Architect.
- E. Configuration: Refer to drawings for specific information.
- F. Wire: No. 12 AWG.

2.10 RETRACTABLE CORD REELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daniel Woodhead Co.
 - 2. McGill
 - 3. Hubbell Company
- B. Description:
 - 1. Electric Cord reel shall be lightweight corrosion-resistant macroblend plastic housing with automatic spring retraction, ratchet lock and lifetime lubrication. Cord reel should be rated for light to medium duty.

2. Cord reel shall have an external spring tension adjustment and an adjustable ball stop on the cord. Provide a 330° pivot base for each cord reel.
3. Cord reel shall have a Type SJO cord with three (3) #16 AWG conductors rated for 300 volts and a length of 30 feet.
4. Cord reel shall have a manufacturer's standard finish to be confirmed by Architect and be UL listed.
5. Provide a NEMA 5-20R, 2 pole, 3 wire receptacle rated for 20 amperes at 125 volts on the end of the cord as indicated on the drawings.

2.11 PIN AND SLEEVE CONNECTORS

- A. Manufacturers: Subject to the compliance with the requirements, provide products by one of the following:
 1. Hubbell Companies; "Circuit Lock" Series (Basis of Design)
 2. Eaton/Arrow Hart; "Pin and Sleeve" Series
 3. Pass and Seymour; "Non-Fusible Interlock" Series
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of integral disconnecting means, pin/sleeve receptacle, interlocking device and enclosure. All pin and sleeve devices shall be IEC 60309-1 and IEC 60309-2 rated.
- C. Environmental Operating Conditions: +60 degrees Celsius to -50 degrees Celsius maximum conditions for continuous operation.
- D. Description: Factory-assembled and wired units consisting of an interlocking, non-fused disconnect switch and pin/sleeve receptacle contained within a single, NEMA 4X watertight enclosure.
 1. Integral disconnect switch shall be horsepower rated and be surface mounted via DIN rail connector for future servicing.
 2. Enclosure housing shall use brass inserts and stainless steel screws for proper torque and sealing.
 3. Enclosure shall have a minimum of two (2) molded-in conduit drill points for connection of incoming feeder; location of feeder to be determined in field.
 4. Bottom or top incoming feeder connection shall have watertight conduit hub, grounding plate and integral captured neoprene gasket for watertight seal.
 5. Heavy-duty, lockable handle meeting OSHA Lockout/Tagout regulations.
 6. Two-stage interlocking tamper-proof mechanism to prevent energizing of power until plug and receptacle are fully engaged; Disconnecting of plug from device cannot occur until power is disengaged by moving handle to the "OFF" position.
 7. Integral pre-wired pin and sleeve receptacle.
 8. Spring-loaded liftcover with gasket for watertight seal.
 9. Adjustable mounting feet suitable for surface mounting on smooth and irregular surfaces.
 10. Color-coded rating label and receptacle mount to indicate voltage and amperage of unit.
- E. Refer to drawings for ampacity, wiring configuration, voltage and ratings of pin and sleeve connectors to be used throughout project.

- F. Device maximum voltage rating shall be 600 volts AC with a minimum short circuit rating of 10,000 AIC.
- G. Device operations shall be rated for 15,000 mechanical cycles and 10,000 electrical cycles.
- H. Auxiliary contacts shall be provided where indicated on drawings. Auxiliary contacts shall be rated for 10 amperes at 600 volts and be available as one (1) normally-open and one (1) normally-closed.
- I. Enclosure shall be non-metallic with provisions for grounding and provided with a gray color finish.

2.12 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: To be confirmed by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: .
 - 3. Wiring devices for Automatic Outlet Control Systems shall be permanently marked with the I/O power symbol and the word "Controlled" in accordance with the NEC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:

- a. Cut back and pigtail or replace all damaged conductors.
- b. Straighten conductors that remain and remove corrosion and foreign matter.
- c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Light Switch Installation

1. Neon or LED lighted handle type light switches - Illuminated when load is "OFF" (meeting the device type, style and color requirements described in other specification sections and drawings) shall be provided for the following applications:
 - a. All "E" designated switches shown on the drawings.
 - b. Manual light switches serving normal and emergency lighting within the following spaces:
 - 1) Electrical Rooms
 - 2) Communications Rooms
 - 3) Mechanical Equipment Rooms
 - 4) Elevator Pits

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Arrangement of Devices: Unless otherwise indicated, mount flush to finished wall surface, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

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. Cartridge fuses rated 600 V and less for use in switches and controllers.
 - 2. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator power module disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. 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.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 15 percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Motor Branch Circuits: Class RK5, time delay, coordinated by final coordination study.
- B. Other Branch Circuits: Class RK5, time delay, coordinated by final coordination study.
- C. Elevator Branch Circuits (Power Module): Class J, time delay, coordinated by final coordination study.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches
 - 2. Nonfusible switches
 - 3. Molded-case circuit breakers
 - 4. Molded-case switches
 - 5. Enclosures

1.3 DEFINITIONS

- A. GD: General duty
- B. GFCI: Ground-fault circuit interrupter
- C. HD: Heavy duty
- D. RMS: Root mean square
- E. SPDT: Single pole, double throw
- F. GFEP: Ground-fault equipment protection
- G. HACR: Heating, air conditioning, refrigeration rated circuit breaker
- H. AFCI: Arc-fault circuit interrupter
- I. SWD: Switch rated circuit breaker
- J. HID: High-intensity discharge switch rated circuit breaker

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. UL listing for series rating of installed devices.
 - 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. 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.

1. Square D/Group Schneider (Basis of Design).
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Siemens Energy & Automation, Inc.
 4. Eaton Corporation; Cutler-Hammer Products.
 5. Hubbell
- B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Manufacturers:
1. Square D/Group Schneider (Basis of Design)
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Siemens Energy & Automation, Inc.
 4. Eaton Corporation; Cutler-Hammer Products
- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A 5-mA trip sensitivity.
7. GFEP Circuit Breakers: Single- and two-pole configurations with Class B 30-mA trip sensitivity.
8. AFCI Circuit Breaker: Single- and two-pole configurations with arc-fault protection.
9. SWD Circuit Breaker: Single-pole configuration, rated for switching fluorescent lighting circuits.
10. HID Circuit Breaker: Single- and two-pole configurations, rated for switching high-intensity discharge circuits.
11. HACR Circuit Breakers: Single-, two- and three-pole configurations, rated for protecting heating, air conditioning and refrigeration equipment.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment; Type HID for switching high-intensity discharge lighting loads.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Arc-Fault Protection: Integrally mounted relay and trip unit with fixed pickup and time-delay settings, push-to-test feature, and arc-fault indicator.
6. Communication Capability: Circuit-breaker-mounted, universal-mounted integral or din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Sections "Switchboards" and "Electrical Metering" where required by drawings and/or other specifications.
7. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
8. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
9. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:

1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.

4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.4 ELEVATOR POWER MODULE PANEL

A. Available Manufacturers:

1. Cooper/Bussman (Basis of Design)
2. Cutler Hammer
3. Square D

B. Provide Power Module Panel as shown on drawings for single and multi-elevator machine rooms. The Power Module panel shall be constructed, listed and certified to the standards as listed. The Power Module Panel shall be rated as indicated on single line diagrams with copper bus.

C. The Power Module Panel shall have individual horsepower rated fusible feeder switches with shunt trip capabilities. Feeder switches shall have ampere ratings based upon elevator manufacturer requirements and utilize class J fuses.

D. All shunt trip fusible feeder switches shall have an accessory a relay, control power transformer and other options (as listed below).

E. The control power transformer shall be 100VA with primary and secondary fuses. The primary voltage rating shall be 480 volts with a 120 volt secondary. The isolation relay shall be 3PDT, 10 amp, 120V. The coil of the isolation relay shall be 120V AC or 24V DC. Contractor shall confirm voltage with fire alarm manufacturer. A normally open dry contact shall be provided by the fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V). (Note: if 24V DC coil is selected, a separate 24V DC source and contact may need to be provided in order to comply with the Fire Alarm Safety System power requirements.)

F. Additional accessories provided for each fusible shunt trip switch include:

1. Key to Test Switch
2. ON Pilot Light (Red)
3. 1P NC Mechanical Interlock (required for hydraulic elevators with automatic recall)
4. Fire Alarm voltage Monitoring Relay (needed to comply with NFPA 72)

G. The module shall have been successfully tested to a short circuit rating with Bussmann Low-Peak Class J fuses at 200,000 amps RMS symmetrical. All switches shall have shunt trip capabilities at 120V AC or 24V DC from remote fire alarm system signal.

2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Infrared Scanning:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - b. Instruments, Equipment and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 28 16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

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 AC, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Reduced-voltage controllers.
 - 3. Multispeed controllers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

- D. Qualification Data: For manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. 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.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two weeks in advance of proposed interruption of electrical service.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
 2. Cerus
 3. Danfoss Inc.; Danfoss Electronic Drives Div.
 4. Eaton Corporation; Cutler-Hammer Products
 5. General Electrical Company; GE Industrial Systems
 6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group
 7. Siemens/Furnas Controls
 8. Square D
 9. Toshiba International Corporation

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
1. Control Circuit: 120 V; obtained from integral control power transformer with a control power of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 2. Adjustable Solid State Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 MULTISPEED ENCLOSED CONTROLLERS

- A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
1. Compelling relay to ensure that motor will start only at low speed.
 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
 3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Refer to the HPE drawings for control switches and stations to be factory installed on controller.
- C. Provide pilot light in cover, red LED type.
- D. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop push button.
- E. Provide two sets of normally open auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor. Provide one set of auxiliary contacts convertible to normally closed. Where starter is provided with Division 23 equipment, it is to be provided with necessary contacts required to operate mechanical equipment and Automatic Temperature Controls, Division 23.
- F. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

- G. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- H. Control Relays: Auxiliary and adjustable time-delay relays.
- I. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
- J. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.6 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled. Horsepower ratings indicated on drawings are for basis of design only. Coordinate horsepower rating of controllers with the motor horsepower supplied with the equipment furnished under Division 22 and 23

3.3 INSTALLATION

- A. For control equipment at walls, mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Install freestanding equipment on concrete bases.

- C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Report results in writing.
- C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- E. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters and Motor Control - Adjustable Speed Drive Systems." Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 29 13

SECTION 26 43 13 – SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 SPD for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for devices with integral SPD.
 - 2. Division 26 Section "Panelboards" for factory-installed SPD.
 - 3. Division 26 Section "Switchboards" for factory-installed SPD.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protective Device.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:
 - 1. UL 1283
 - 2. UL 1449 (3rd Edition 2009)
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements
 - 3. Failed test results and corrective action taken to achieve requirements.

- E. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain surge protective devices and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. 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.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Standard for Surge Protective Devices." Provide a Manufacturer's Certificate certifying transient voltage surge suppression device complies with UL1449 Third Edition Surge Voltage Ratings.

1.6 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 12,000 feet above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted surge protective devices to allow adequate clearances for maintenance.
- B. Coordinate surge protection devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within ten years from date of Substantial Completion.
- B. Special Warranty for Cord-Connected, Plug-in Surge Protective Devices: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric (Basis of Design)
 - 2. Cutler-Hammer, Inc.; Eaton Corporation
 - 3. General Electric

2.2 SERVICE ENTRANCE SURGE PROTECTIVE DEVICES

- A. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Integral disconnect switch.
 - 4. Redundant suppression circuits.
 - 5. Redundant replaceable modules.

6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with electrical power monitoring and control system.
 10. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
- C. Connection Means: Permanently wired.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277, 700V for 208Y/120.
 2. Line to Ground: 1200 V for 480Y/277, 700V for 208Y/120.
 3. Neutral to Ground: 1200 V for 480Y/277, 700V for 208Y/120.

2.3 DISTRIBUTION PANELBOARD SPD'S

- A. Surge Protective Device: IEEE C62.41-compliant, integrally mounted, plug-in solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
 - a. Integral disconnect switch.
 - b. Redundant suppression circuits.
 - c. Redundant replaceable modules.
 - d. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - e. LED indicator lights for power and protection status.
 - f. Audible alarm, with silencing switch, to indicate when protection has failed.
 - g. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with electrical power monitoring system.
 - h. Six-digit, transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
- C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277 208Y/120, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277, 700 V for 208Y/120.
 2. Line to Ground: 1200 V for 480Y/277, 700 V for 208Y/120.
 3. Neutral to Ground: 1200 V for 480Y/277, 700 V for 208Y/120.

D. Protection modes and UL 1449 VPR for voltages of 480, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V, 1200 V for 240 V
2. Line to Ground: 1200 V for 480 V, 1200 V for 240 V

2.4 SPD'S FOR APPLIANCE AND LIGHTING PANELBOARDS

A. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:
 - a. Integral disconnect switch.
 - b. Redundant suppression circuits.
 - c. Redundant replaceable modules.
 - d. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - e. LED indicator lights for power and protection status.
 - f. Audible alarm, with silencing switch, to indicate when protection has failed.
 - g. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with electrical power monitoring system.
 - h. Six-digit, transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Rating: 80 kA per phase.

C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277, 700 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277, 700 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277, 700 V for 208Y/120.

D. Protection modes and UL 1449 SVR for voltages of 480, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V, 1200 V for 240 V
2. Line to Ground: 1200 V for 480 V, 1200 V for 240 V

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Switchboards, distribution panelboards, lighting panelboards, appliance panelboards, and electronic grade panelboards integral to electrical equipment.
- B. Install devices for panelboard and auxiliary panels with conductors or buses between surge protective device and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multipole, 30-A minimum circuit breaker integral into the panelboard the SPD is installed as a dedicated disconnect for suppressor, unless otherwise indicated.
- C. Install indicator lights, trouble alarms and surge counter in face of switchboard, switchgear and panelboard.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service entrance equipment, panelboards, control terminals and data terminals to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:
- C. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 - 4. Test units to specified surge ratings to ensure devices will achieve required life expectancy and reliability. Testing to full ratings also verifies internal construction quality of suppressors. Provide withstand testing for each mode and each phase basis.
 - 5. Perform actual Let-Through voltage test data in form of oscillography results for ANSI/IEEE C62.41 Catalog C3 (20 kV, 10 kA), Catalog C1 (6 kV, 3 kA), and Catalog. B3 (6 kv, 500 A at 100 kHz) tested in accordance with ANSI/IEEE C62.45.

6. Perform spectrum analysis of each unit based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying device noise attenuation exceeds 45 dB at 100 kHz.
 7. Perform test verifying suppressors can survive published surge current rating for each mode and each phase basis. Test wave based on ANSI/IEEE C62.41, 8x20 microsecond current wave.
 8. Test Reports: Provide test reports indicating compliance with all testing requirements and procedures, including the following:
 - a. Indicate Let-Through voltage test data.
 - b. Submit spectrum analysis of each unit.
 - c. Submit test reports from nationally recognized independent testing laboratory verifying suppressors can survive published surge current rating.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 43 13

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and drivers
 - 2. Emergency lighting units
 - 3. Exit signs
 - 4. Lighting fixture supports
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, wall box dimmers, and multipole lighting relays and contactors.
 - 2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

- A. BF: Ballast factor
- B. CRI: Color-rendering index
- C. HID: High-intensity discharge
- D. LER: Luminaire efficacy rating
- E. Luminaire: Complete lighting fixture, including ballast housing if provided

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.

3. Driver, including manufacturer.
 4. Energy-efficiency data, including lamp type, manufacturer.
 5. Lamp and driver warranty information.
 6. Life, output, and energy-efficiency data for lamps.
 7. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
- B. Luminaire submittals not including lamp and driver types and manufacturer's name will be returned marked "not reviewed". Lamp and ballast types and manufacturer's name must be submitted with the luminaire submittals in order to review.
- C. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power and control wiring.
- D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for lighting fixtures will be attached.
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets
 - b. Speakers
 - c. Sprinklers
 - d. Smoke and fire detectors
 - e. Occupancy sensors
 - f. Access panels
 5. Perimeter moldings.
- E. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
1. Lamps: Specified units installed
 2. Accessories: Cords and plugs
- F. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- G. Qualification Data: For agencies providing photometric data for lighting fixtures.
- H. Field quality-control test reports.

- I. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. 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.
- C. Comply with NFPA 70
- D. Comply with the recommended standards of the Illuminating Engineering Society of North America.
- E. Comply with the requirements of ASHRAE 90.1, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
- F. LED Compliance: LED components, lamps, drivers and fixtures shall comply with: PCC 47 CFR Part 15; UL 8750; ANSI/NEMA Standards C78.377, NEMA SSL-1, ANSI C82.77, IESNA Standards TM-16-05, RP-16, LM-79, LM-80 and TM-21.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency drivers and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

- B. Special Warranty for Complete LED Luminaire Assembly: Provide a five year manufacturer's warranty on LED luminaires including full replacement of any failed components and \$50 labor allowance for each luminaire. Warranty shall be from the date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.
 - 4. Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 5. Globes and Guards: 1 for every 30 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. Luminaires
 - a. Refer to "Luminaire Schedule", herein or on the Drawings.
 - 2. LED Lamps and Modules:
 - a. Philips
 - b. General Electric
 - c. Osram-Sylvania
 - d. Cree
 - e. Nichia
 - f. Xicato
 - g. Bridgelux
 - 3. LED Power Supplies
 - a. Osram-Sylvania
 - b. General Electric
 - c. Philips
 - 4. LED Dimming Drivers
 - a. Lutron

5. Substitutions -Under provisions of Division 1

- a. All proposed substitutions to the listed approved manufacturers must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the Bid Date and shall be made available to all bidders.
- b. Any substitutions (other than as directed by the owner) proposed by the contractor after the bid date shall be reviewed by the electrical engineer at a rate of \$150 per hour at the contractors expense. A signed contract between the contractor and the design professional for such work is required before commencement of review.
- c. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuiting, devices and wiring. The contractor shall provided complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Luminaires shall bear UL inspection label, suitable to application and installed environment.
- C. Furnish on request I.T.L. and/or E.T.L. test reports for luminaires furnished.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent
 2. Specular Surfaces: 83 percent
 3. Diffusing Specular Surfaces: 75 percent
 4. Laminated Silver Metalized Film: 90 percent
- H. Plastic Diffusers, Covers, and Globes:
 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.

- I. Luminaire housing and door frame shall be fully sealed against light leakage. Light leaks between ceiling trims of recessed luminaires and ceiling will not be acceptable.
- J. Alzak parabolic cones shall be guaranteed against fading for a minimum of 2 years. In the event of premature fading, luminaire manufacturer shall replace cones and pay for both labor and material costs.
- K. Adjustable luminaires shall be capable of being locked into position. Aim and adjust all adjustable luminaires to the satisfaction of the Owner and the Architect.
- L. Maximum depth of recessed tubular-fluorescent luminaires shall not exceed 6 inches including mounting yokes. Reflector and lamp positions shall provide highest efficiency and even brightness to eliminate lamp lines on diffusers.
- M. Recessed luminaires shall be removable from below to provide access to outlet or prewired luminaire box.
- N. A snap type local disconnect shall be provided for all luminaires. The disconnect shall disconnect all supply conductors simultaneously, including the grounded conductor. The line side terminals of the disconnecting means shall be guarded. The disconnecting means shall be located inside or outside the luminaire housing, but must be accessible to qualified persons before servicing or maintaining the ballast or lamps.

2.3 EMERGENCY POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with driver. Comply with UL 924.
 - 1. Emergency Connection: Operate LED module continuously at an output of 1100 lumens. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
 - 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 5. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 3. Charger: Fully automatic, solid-state, constant-current type.
 4. Housing: NEMA 250, Type 1 enclosure.
 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
 9. External type must be provided for all sealed fixtures.

2.4 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

3. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.
4. Type "X" Directional Exit Signs shall have directional indicating chevrons pointing in direction of travel.

2.5 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 1. Battery: Sealed, maintenance-free, lead-acid type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

- D. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element. Coordinate with ceiling installer (Division 9).
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Attach to grid and locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Adjust aimable lighting fixtures to provide required light intensities. Adjust to satisfaction of Architect and Owner.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- F. Do not install reflector cones and visible trim of luminaires until completion of plastering, ceiling tile work, painting, and general cleanup. Installation of reflector cones and visible trim of luminaires shall be carefully coordinated with ceiling openings to prevent light leaks at the ceiling plane. Handle cones and trim carefully to avoid scratching or finger printing. Luminaires shall be completely clean at time of acceptance by Owner.

- G. Plaster frames (frame-in-kits) for all recessed fixtures shall be installed per manufacturer's instructions and in a rigid manner so as not to allow fixture frame or housing to move or shift when trim is removed or fixture is relamped. If plaster frame shifts when relamped or trim is not tight to ceiling, or the fixture has not been installed per the manufacturer's instructions, the Contractor shall resecure frames and have ceiling patched and refinished at their expense. General Contractor to spackle gap between rough g.w.b. opening and the plaster frame of light fixture to avoid light-leak and allow for narrow or flangeless trims to be used.
- H. Drywall suspension ceiling systems will be provided with supplemental steel stud channels at luminaire locations for supporting luminaires to ceiling system under Section 09 26 00, Gypsum Wallboard Systems. Securely fasten recessed and/or surface mounted luminaires to steel channels with approved earthquake clips or clamping devices. Where required by local codes, where ceiling systems are not seismically braced or where the weight of the luminaire may cause deformation of the suspended ceiling, provide independent seismic restraint supports for luminaires connected to the structure above. The amount of deformation allowed is specified in Section 09 26 00.
- I. Where MC and/or AC cable is not allowed for branch circuiting as described in Specification Section 260519, extend conduit to an accessible junction box within six feet of luminaires and provide a maximum six foot length of flexible conduit (Greenfield) and wire to each luminaire. Where MC and/or AC cable is allowed for branch circuiting as described in Specification Section 260519, extend AC and/or MC cable to an accessible junction box within six feet of luminaires and provide a maximum six foot length of AC and/or MC cable to each luminaire. Locate box so that luminaires can be readily moved into adjacent modules and to provide access to space above ceiling. Support flexible conduit or cable from structure; do not lay on ceiling tiles or attach to any support systems.
- J. Properly align all surface type luminaires. Bolt together so that alignment will be permanent.
- K. Mount under cabinet luminaires as indicated on architectural details. If cabling to luminaires is not concealed, provide wiremold cover to conceal wiring, color as directed by Architect.
- L. Provide mock-ups of fixtures as specified for approval of Engineer/Architect/Owner prior to release of fixture order.
- M. Provide aiming of adjustable fixtures to the satisfaction of Engineer/Architect/Owner.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and drivers
 - 2. Luminaire-mounted photoelectric relays
 - 3. Poles and accessories
- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings

1.3 DEFINITIONS

- A. CRI: Color-rendering index
- B. HID: High-intensity discharge
- C. Luminaire: Complete lighting fixture, including driver housing if provided
- D. Pole: Luminaire support structure
- E. Standard: Same definition as "Pole" above

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 2. Details of attaching luminaires and accessories.
 3. Details of installation and construction.
 4. Luminaire materials.
 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, drivers, and accessories.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 6. Photoelectric relays.
 7. Drivers, including energy-efficiency data, manufacturer, warranty information
 8. LED modules/lamps, including life, output, and energy-efficiency data, manufacturer, warranty information.
 9. Materials, dimensions, and finishes of poles.
 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 11. Anchor bolts for poles.
- B. Luminaire submittals not including lamp and driver types and manufacturer's name will be returned marked not reviewed. Lamp and driver types and manufacturer's name must be submitted with the luminaire submittals in order to review.
- C. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 3. Wiring Diagrams: Power and control wiring.
- D. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and drivers.
- E. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- F. Qualification Data: For agencies providing photometric data for lighting fixtures.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

- I. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- 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 IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.
- F. Comply with the recommended standards of the Illuminating Engineering Society of North America.
- G. Comply with the requirements of ASHRAE 90.1, Energy Standard for Buildings, Except Low-Rise Residential.
- H. LED Compliance: LED components, lamps, drivers and fixtures shall comply with: PCC 47 CFR Part 15; UL 8750; ANSI/NEMA Standards C78.377, NEMA SSL-1, ANSI C82.77, IESNA Standards TM-16-05, RP-16, LM-79, LM-80 and TM-21.
- I. Luminaires shall bear UL inspection label, suitable to application and installed environment.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on fiberglass poles until right before pole installation. Handle poles with web fabric straps.
- D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Complete Luminaire Assembly (including LED modules, drivers, etc.): Five years from date of Substantial Completion.
 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 4. Warranty Period for Poles: Repair or replace lighting poles that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. LED Modules: 1 for every 30 of each type and rating installed. Furnish at least one of each type.
 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 30 of each type and rating installed. Furnish at least one of each type.
 3. Drivers: 1 for every 30 of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Acceptable Manufacturers
1. Luminaires
 - a. Refer to "Luminaire Schedule", herein or on the Drawings.
 2. LED Lamps and Modules
 - a. Phillips

- b. Osram-Sylvania
 - c. General Electric
 - d. Cree
 - e. Nichia
 - f. Xicato
 - g. Bridgelux
3. LED Drivers
- a. Philips
 - b. General Electric
 - c. Osram-Sylvania
4. LED Dimming Drives
- a. Lutron
5. Substitutions -Under provisions of Division 1
- a. All proposed substitutions to the listed approved manufacturers must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the Bid Date and shall be made available to all bidders.
 - b. Any substitutions (other than as directed by the owner) proposed by the contractor after the bid date shall be reviewed by the electrical engineer at a rate of \$150 per hour at the contractor's expense. A signed contract between the contractor and the design professional for such work is required before commencement of review.
 - c. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuiting, devices and wiring. The contractor shall provided complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent
 - 2. Specular Surfaces: 83 percent
 - 3. Diffusing Specular Surfaces: 75 percent
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Adjustable luminaires shall be capable of being locked into position. Aim and adjust all adjustable luminaires to the satisfaction of the Owner and the Architect.
- M. All exterior luminaires, and those in wet/damp locations, shall be fitted with seals and gaskets to form a weatherproof, watertight assembly, and shall be of rust resistant construction and finish.
- N. Luminaire Finish: Manufacturer's standard paint (unless otherwise noted in luminaire schedule) applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.
- P. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As selected by Architect from manufacturer's full range.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.4 LED SYSTEMS

- A. The LED module itself and all its components must not be subjected to mechanical stress.
- B. Assembly must not damage or destroy conducting paths on the circuit board.
- C. Installation of LED modules (with power supplies) shall adhere to all applicable electrical and safety standards.
- D. Correct electrical polarity shall be clearly identified.
- E. LED module must be protected from unbalanced voltage drop, and/or overload.
- F. Ensure that the power supply is of adequate power to operate the total load.
- G. Utilize standard ESD precautions when installing the module.
- H. Install system according to the manufacturers heat sinking parameters.
- I. For applications involving exposure to humidity and dust, the module shall be protected by a fixture or housing with a suitable protection glass. The module shall be protected against condensation water by treatment with an appropriate circuit board conformal coating. The conformal coating should have the following features.

1. Optical transparency
 2. UV resistance
 3. Thermal expansion properties matching those of the module (15-30 x 10-6cm/cm/K)
 4. Low permeability of steam for all climate conditions
 5. Resistance against corrosive environments
- J. The LED Module shall be operated with an electronically stabilized power supply offering protection against short circuits, overload and overheating.
- K. All LED products shall respect Intellectual Property Rights and shall have a Solid State License for the product. Unlicensed products are not acceptable.
- L. LED Driver shall be installed inside an electrical enclosure suitable for use in dry, damp, or wet location as required by fixture listing.
- M. Wiring inside electrical enclosure shall comply with 600V/105°C rating or higher.
- N. LED Driver shall meet the following:
1. Class A sound rating.
 2. An operating ambient temperature range of -20°C to 55°C.
 3. A maximum life expectancy of 50,000 hours at Tcase of $\leq 70^{\circ}\text{C}$.
 4. A maximum life expectancy of 100,000 hours at Tcase of $\leq 62^{\circ}\text{C}$.
 5. Function to reduce output power to LEDs if its maximum allowable case temperature is exceeded.
 6. A failure rate of $\leq 0.01\%$ per 1,000 hours at Tcase of $\leq 70^{\circ}\text{C}$.
 7. A failure rate of 0.01% - 0.02% per 1,000 hours at Tcase of 70°C - 80°C.
 8. Tolerance for sustained open circuit and short circuit output conditions without damage.
 9. Power Factor > 90%.
 10. Total harmonic Distortion < 20%.
 11. Compliance with FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).
- O. Where a dimming LED driver is specified, ensure compatibility of driver and dimming control system.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.6 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
 - 1. Shape: See Schedule on Drawings.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adapter fitting welded to pole and bracket, then bolted together with stainless or galvanized-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.

2.7 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: See Schedule on Drawings.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Same as luminaire.
 - 3. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

4. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
5. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As selected by Architect from manufacturer's full range.

2.8 COMPOSITE POLES

- A. Poles: Comply with ANSI C136.20, with access handhole in pole wall.
 1. Mounting: Embedded.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Resin Color: As selected by Architect from manufacturer's full range; provide uniform coloration throughout entire wall thickness.
- C. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils.

2.9 POLE ACCESSORIES

- A. Duplex Receptacle (when indicated on drawings): 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
 1. Recessed, 12 inches above finished grade.
 2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, that when mounted results in NEMA 250, Type 3R enclosure.
 3. With cord opening.
 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- C. Decorative accessories, supplied by decorative pole manufacturer, include the following:
 1. Banner Arms (if indicated on drawings): See drawing details for material information.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps/LED modules in each luminaire.

- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Position adjustable flood luminaires and landscape luminaries at night to satisfaction of the Architect and Owner. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.
- D. Install exterior luminaires on building on rust-resistant nonferrous cast outlet boxes set flush in exterior walls and fitted with seals and gaskets. Conceal all wiring in or within the construction.
- E. Install exterior luminaires where surface mounted using rust-resistant nonferrous outlet boxes and fittings.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers, unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 - 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Make holes 6 inches in diameter larger than pole diameter.
 - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).
- I. Mount poles on approved foundations, setting them plumb and true utilizing leveling nuts and torquing top nuts adjusted to a value recommended by pole manufacturer.
- J. Tack-weld top nuts in place. Grout void space between pole base and concrete foundation with nonshrinking material. Provide short piece of 1/8 inch diameter drain pipe through grout from pole interior to outside.
- K. Exercise care in unloading and erecting poles and touch up burns, scratches and chips in finish by using matching materials provided by manufacturer.
- L. Coordinate installation of bases with work performed in Section 02200.
- M. Protect all luminaires, poles and wiring during construction period from damage or breakage and leave in operating condition.
- N. Securely fasten luminaires in place; properly connect to branch circuits with solderless connectors and tape; install specified lamps.
- O. Relocate existing luminaires and poles where indicated. Move and reinstall at new location or turn over to Owner as directed.
- P. Provide underground wiring in conduit with watertight connections. Make cable entrances to and from pole, post or bollard type luminaires, in 1 inch (minimum) galvanized rigid metal conduit through foundation terminating 2 inches above top of foundation in a bushing.

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location, unless noted otherwise per drawings. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches, unless otherwise noted, above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."

- c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Completely test entire installation and leave in satisfactory operating condition.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

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. The work included under this Specification consists of furnishing labor, equipment, materials, supplies and performing operations necessary to complete the installation. The Contractor shall provide and install the required material whether specifically addressed in the technical specifications or not.
- B. The work includes, but not be limited to the following:
 - 1. Wall lining.
 - 2. Cable runway.
 - 3. Power distribution units
 - 4. Busbar and bonding of runway and mounting frames within telecommunications rooms

1.3 REFERENCED STANDARDS AND CODES

- A. Compliance with the following published codes, standards, and tests and recommended methods of trade, industry, or governmental organizations are required for Work in this section.
 - 1. Execute work in accordance with the following list of TIA standards.
 - a. TIA-569-D Commercial Building Standard for Telecommunications Pathways and Spaces
 - b. TIA-606-C Administration Standard for Commercial Telecommunications Infrastructure
 - c. ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 2. Other
 - a. BICSI Telecommunications Distribution Methods Manual (TDMM), 14th Edition
 - b. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - c. National Electrical Code, NEC 2020
 - d. Underwriters Laboratories (UL)
 - e. Americans with Disabilities Act (ADA)
 - f. Requirements of the local authority having jurisdiction (AHJ).

1.4 DEFINITIONS

- A. In addition to those Definitions of Division 01, the following list of terms as used in this Section shall be defined as follows:

1. Furnish – To purchase, procure, acquire, and deliver complete with related accessories.
2. Install – To set in place, join, attach, link, set up or otherwise connect together and test until complete before turning over to the Owner, all parts, items, or equipment supplied by Contractor.
3. Provide – To furnish and install.
4. Some processes, methods, and procedures, as well as spaces, rooms and structure, may be abbreviated or used interchangeably within this section. The following list is presented to reconcile these differences within this section.
 - a. Structured Cabling System (SCS): A SCS is defined as all required cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity from each data or voice device to the network file server or voice network/switch designated as the service point of the local area network.
 - b. Telecommunications Space (TS) - A common area used for telecommunications cabling terminations and the location of telecommunications equipment.
 - c. Equipment Room (ER) - An environmentally controlled space that is the primary point of interconnection between the communication facility provided by the public switched telephone company network and the building's communications facility.
 - d. Telecommunications Room (TR) – An environmentally controlled space that is the telecommunications structured cabling distribution point. The TR is designated for housing communications equipment and related wiring that serves a specific area of the building. Formally known as an IDF.
 - e. Horizontal Distribution Cabling - The telecommunications cable, Category or fiber optic, routed between a TR, TE or the ER and a work area outlet.
 - f. WAO: Work Area Outlet. The workstation end-point of horizontal distribution cable. An icon legend is provided on the related drawings, and symbols or legends represent the type and quantity of cables terminated at the WAO.
 - g. TMGB: Telecommunications Main Grounding Busbar - The common source for bonding telecommunications equipment within the ER.
 - h. TGB: Telecommunications Grounding Busbar - The common source for bonding telecommunications equipment within the EF, TR or TE.
 - i. TBB: Telecommunications Bonding Backbone.
 - j. TBC: Telecommunications Bonding Conductor.

1.5 PROJECT CONDITIONS

- A. Verify dimensions and conditions on the job site applicable to this work. Notify the Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. The drawings diagrammatically show device outlet locations and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and submit drawings to the Architect for approval showing how the work may be installed.
- C. If a conflict develops between the contract documents and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification.

When a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform work.

- D. During the course of construction, room names and/or room numbers may be changed. For continuity during installation the Contractor shall refer to rooms and spaces by their identities as shown on the ES series drawings. This shall apply to all correspondence, RFI's, proposal requests, and submittal packages pertaining to this Section.
- E. Provide temporary or permanent protection of products bearing the UL label that risk exposure to conditions that may compromise any portion of the product.

1.6 SCOPE SUMMARY

- A. This entire specification section and the project drawings define the requirements for the installation of equipment in telecommunications spaces to support a SCS. The following is intended to summarize the Work and clarify design intent and is not an exhaustive description of the work required.
- B. Coordinate exact location and installation of the following:
 - a. Conduits, wire-ways, cable trays external to the telecommunication spaces, floor boxes, wall boxes, pull boxes, and junction boxes
 - b. Slots and sleeves
 - c. Firestopping products
 - d. AC power circuits for telecommunications equipment
 - e. AC power circuits within telecommunications spaces
 - f. Plywood wall linings within telecommunications spaces
 - g. Lighting requirements within telecommunications spaces
 - h. MEP systems and equipment terminating within or intersecting telecommunications spaces
 - i. Telecommunications grounding and bonding system required for telecommunications spaces
 - j. Wireless access points data outlet with light fixtures, HVAC ductwork, and architectural elements
 - k. Incoming service provider circuits
- C. Deliver Submittals, Shop Drawings and Cable Test Records as specified herein.
- D. Obtain permits, licenses, or other municipal requirements and pay any fees required for the execution of this Work.
- E. Provide bonding of equipment racks, and cable pathway system in accordance with equipment manufacturer's requirements and ANSI/TIA 607-C Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- F. Supply accessories and minor equipment parts required to make telecommunications spaces ready for SCS and other systems to be installed in the space, even if not specifically mentioned in these Specifications or on the drawings, without claim for additional payment.

1.7 CONTRACTOR QUALIFICATIONS

- A. Must have five plus (5+) years of experience with equipment and systems of the specified types.
- B. Must have completed a minimum of three comparable scaled projects within the last two years.
- C. Must maintain a fully staffed and equipped service facility.
- D. Must perform operations necessary to complete the telecommunications space build out in accordance with these specifications utilizing related drawings.
- E. At the request of the Architect, the Contractor must demonstrate an adequate staff with commensurate technical experience available.
- F. At the request of the Architect, the Contractor must demonstrate adequate plant and equipment available to complete the work.

1.8 PRE-CONSTRUCTION SUBMITTALS

- A. Project Submittal Requirements are defined in the Project Manual. The successful Contractor must make one single, complete pre-construction Submittal package as defined and described in the General Section, with the following additional technology specific details.
 - 1. Provide a Drawing-List of submitted drawings. The submittal shop drawings are to be used by the Contractor as a basis for revision mark ups to create the “as-built” conditions.
 - a. Execute drawings at an appropriate scale but no smaller than 1/8”.
 - b. Large-sheet drawings.
 - 1) Submit drawings rendered in AutoCAD™ or an AutoCAD™-compatible application.
 - 2) Create drawings using a monochromatic scheme and industry-standard graphics with varied line types and weight so the attributes of the various elements of the image are readily discernible.
 - 3) Provide enlarged floor plans of Telecom Rooms with cable tray and racks shown in the rooms shown to scale.
 - 4) Depict any special installation details or unique means and methods necessary to successfully complete the telecommunications pathways installation.
 - 2. Submit appropriate cut sheets and samples for products as detailed in project specifications and drawings. Submittals shall be in electronic PDF format.
 - 3. Work shall not proceed without the approval of the submitted items.
 - 4. No substituted materials shall be installed except by written approval. Only those products that are listed as “or equivalent” in Part 2 of this specification will be considered for substitution. Substitution requests must be submitted as defined in the Project Manual. No substitutions will be considered during the submittal process.
 - 5. Project Submittals Requirements: The pre-construction submittal is required to verify the Contractor will obtain the specified product, understands the processes and procedures, and understands the requirements to install specified equipment system as shown on the drawings.
 - a. The Submittal package is to be delivered for approval prior to commencement of Work, no later than twenty (20) days after issuance of Notice to Proceed.
 - b. Any submittals beyond the original submittal and one resubmittal will result in charges to the Contractor (charged for third and any subsequent reviews).

- c. Additional review fees will be at the prevailing rate in effect at the time that the additional review(s) is (are) required.

1.9 CLOSE-OUT SUBMITTALS

- A. After substantial completion of the installation, revise all drawings to reflect the actual names and numbers assigned to the spaces. Use the actual names and numbers on the as-built drawings, and administration documents.
- B. Submit Close-out documentation in accordance with Division 1 of the Project Manual and any applicable supplements.
- C. Segregate documents into separate sections containing data relevant to operational, maintenance and warranty issues.
- D. Appropriately duplicate data within the other separate sections when it will reasonably clarify procedures, i.e.: operational data in maintenance binder.
- E. Electronic document shall contain the following information:
- F. Products List Document(s)
 - 1. Provide a final, complete list of products and product data sheets (PDS) in an electronic Adobe PDF file format that have been incorporated within the Work, arranged in the same order as specified in the pre-construction submittal.
- G. Record Drawings
 - 1. Provide drawings showing final “owner” room numbering only. Coordinate with the architect prior to submission.
 - 2. Provide “as-built” drawings of the completed cabling installation.
 - 3. The as-built drawings shall indicate:
 - a. The actual locations of racks and pathways.
 - b. The identity information for each Equipment Room
 - c. All field changes, corrections, modifications, and updates to the shop drawings
 - 4. Warranty and Maintenance Document(s)
 - a. Provide a statement explaining the terms and conditions of the Extended Product Warranty and the Application Assurance Warranty to include but not limited to the warranty commencement date and length of warranty. Provide warranty certificates issued by manufacturer.
 - b. Provide a list of contact names, telephone numbers, and hours of operation for normal warranty service.
 - c. Provide a contact name/number for 365/7/24 emergency warranty service with an explanation of limiting conditions if applicable.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Ship product in its original container, to prevent damage or entrance of foreign matter.
- B. Handling and shipping in accordance with manufacturer’s recommendation.

- C. Provide protective covering during construction, to prevent damage or entrance of foreign matter.
- D. Provide warning placards, warning tape or protective barrier systems for temporary protection of products or personnel during installation processes.
- E. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PRODUCT WARRANTY

- A. Contractor's warranty covering all installed products and labor against defects in materials and workmanship for a period of 1 year.
 - 1. Within the 1-year warranty period, answer service calls within 4 hours and begin work to correct the deficiency within twenty-four hours.
- B. Manufacturer Warranty starts the date of projects warranty certification issue to the District from the manufacturer.
- C. A manufacturer's Representative shall inspect and certify all work to validate the manufacturer's warranty

PART 2 - PRODUCTS

2.1 GENERAL

- A. Related Divisions and articles remain applicable to the products specified herein. Any repetition of related specification is for emphasis only.
- B. Products shall be new, free from defects and listed by UL when an applicable UL Standard exists. Provide product of a given type from one manufacturer.
- C. Regardless of the length or completeness of the descriptive paragraph herein, provide product complying with the specified manufacturers published specifications.
- D. Product not specifically identified within this document but which is required for the successful implementation of the intended system(s), shall be of the same class and quality as the specified product and equipment.
- E. Cable and wiring devices provided shall be listed and labeled by Underwriters Laboratories, Inc. for the intended use under the latest appropriate testing standard.
- F. Basis-of-Design Product:
 - 1. Product manufacture and part numbers listed are provide as performance standard, provide products as specified or equivalent product.

2.2 PLYWOOD BACKBOARD (PLYWOOD WALL LINING)

- A. 4' W x 8' H x 3/4" D
 - 1. Fire-rated plywood
 - 2. A/C grade, void-free
 - 3. Paint all sides with Latex Fire Retardant paint
 - 4. Acceptable product
 - a. (As approved by the AHJ)

2.3 CABLE RUNWAY

- A. 12" Wide Cable Runway
 - 1. UL Classified
 - 2. Black in color
 - 3. 1-1/2" x 3/8" tubular steel side rail (stringer)
 - 4. 1/2" x 1" tubular steel cross member
 - 5. 9" cross member spacing
 - 6. Acceptable product
 - a. Chatsworth 10250-712
 - b. Substitutions: Under provisions of Division 01
- B. 12" Wide Cable Runway, Movable Cross Member
 - 1. Required for mounting cross member radius drops
 - 2. Black in color
 - 3. Acceptable product
 - a. Chatsworth Product 12115-712
 - b. Substitutions: Under provisions of Division 01
- C. 12" Wide Cable Runway, Radius Drop - Cross Member
 - 1. Black in color
 - 2. Acceptable product
 - a. Chatsworth 12100-712
 - b. Substitutions: Under provisions of Division 01
- D. 12" Wide Cable Runway, Radius Drop - Stringer
 - 1. Black in color
 - 2. Acceptable product
 - a. Chatsworth 12101-701
 - b. Substitutions: Under provisions of Division 01
- E. Cable Retaining Post
 - 1. Black in color
 - 2. 8" height
 - 3. Acceptable product
 - a. Chatsworth 10596-708
 - b. Substitutions: Under provisions of Division 01

- F. End Closing Kit
 - 1. UL Classified
 - 2. Acceptable product
 - a. Chatsworth ~~11700-71210642-001~~
- G. Butt-Splice Kit
 - 1. UL Classified
 - 2. Acceptable product
 - a. Chatsworth 16301-701
 - b. Substitutions: Under provisions of Division 01
- H. Junction-Splice Kit
 - 1. UL Classified
 - 2. Acceptable product
 - a. Chatsworth 10616-701
 - b. Substitutions: Under provisions of Division 01
- I. Triangular Support Bracket
 - 1. 100 pound load rating
 - 2. Black in color
 - 3. Acceptable product
 - a. Chatsworth 11746-712
 - b. Substitutions: Under provisions of Division 01
- J. Wall Angle Support Bracket
 - 1. Black in color
 - 2. Acceptable product
 - a. Chatsworth 11420-701
 - b. Substitutions: Under provisions of Division 01
- K. Vertical Wall Bracket
 - 1. Black in color
 - 2. Acceptable product
 - a. Chatsworth Product 10608-701
 - b. Substitutions: Under provisions of Division 01
- L. Protective End Caps
 - 1. Acceptable product
 - a. Chatsworth 10642-001
 - b. Substitutions: Under provisions of Division 01
- M. Touch-Up Paint
 - 1. Black in color
 - 2. Acceptable product

- a. Chatsworth 25400-700
- b. Substitutions: Under provisions of Division 01

2.4 GROUNDING

A. Primary Bonding Busbar:

- 1. 4" x 12 x 1/4" copper
- 2. UL listed
- 3. BICSI AND ANSI /TIA hole patterns
- 4. Comes with mounting brackets
- 5. Approved products:
 - a. Chatsworth Part # 40153-012
 - b. Cooper B-Line Part # SBTMGB12
 - c. Substitutions: Under provisions of Division 01

B. Secondary Bonding Busbar:

- 1. 2" x 12 x 1/4" copper
- 2. UL listed
- 3. BICSI AND ANSI /TIA hole patterns
- 4. Comes with mounting brackets
- 5. Approved products:
 - a. Chatsworth Part # 13633-012
 - b. Cooper B-Line Part # SBTGBK
 - c. Substitutions: Under provisions of Division 01

C. #6 CU ground wire:

- 1. Green THHN
- 2. UL listed

D. #6 grounding lug:

- 1. Mechanical compression
- 2. 2 hole
- 3. Approved products:
 - a. Chatsworth Part # 40162-913
 - b. Cooper B-Line Part # SB47902
 - c. Substitutions: Under provisions of Division 01

PART 3 - EXECUTION

3.1 BACKBOARDS

- A. Provide rated fire retardant, painted plywood on walls of telecommunications rooms as shown on the drawings and secured flush with wall framework.
- B. Install with fire rating stamp visible on each sheet of plywood.

- C. Fire retardant paint shall be light in color to enhance lighting.
- D. Install sheets side by side 6" off the floor with the 8' length vertical unless otherwise noted on the drawings.
- E. Provide two overlapping layers of the specified plywood when covering masonry walls.
- F. Plywood shall be permanently fastened to the wall by means of wall anchors utilizing galvanized, zinc plated, or stainless steel hardware with a flat head.
 - 1. Finished installation shall have a flush appearance with countersunk screw heads to prevent splitting of the plywood.
 - 2. Drywall screws are not acceptable.
- G. Plywood and paint shall be coordinated with the AHJ to meet applicable codes.

3.2 CABLE RUNWAY

- A. Provide cable runway as required to maintain cable fill ratios specified in referenced Standards, to provide routing and support of cables entering into and within the rooms and properly support cable distribution.
- B. Provide overhead ladder runway in the configuration as shown on the drawings.
 - 1. Provide wall angle brackets and attach the ends of the ladder runway to walls.
 - 2. Where possible, provide and attach the ladder runway to equipment cabinets with cabinet to runway mounting plates and elevation kits.
 - 3. Provide support for the ladder runway every 5 feet.
 - a. Cable runway will be mounted at a height of 7'-6" or 6" above equipment cabinets/racks unless noted otherwise.
 - b. Support runway with equipment cabinets
 - c. Support runway with triangle wall brackets
 - d. Support runway from above with (2) support brackets and 3/8" threaded rod attached to building structure.
 - 1) Attach threaded rod to building structure using concrete anchors, beam clamps, or other devices designed for building attachment. Connections must have a pull-out strength and be spaced to provide support for the ladder runway to meet the manufacturer's load rating for the ladder runway.
 - 2) Provide plastic threaded rod covers to cover lower 2 feet of threaded rod.
 - 4. Provide any seismic bracing required by local codes for free-standing racks designed and sealed by a registered professional engineer licensed to practice in the state.
 - 5. Field cuts must be filed smooth, dressed square, and painted to match.
 - 6. Provide end caps on all exposed ladder runway ends.
 - 7. Provide and connect all ladder runway with appropriate butt splice kits, junction splice kits and other hardware designed for assembly of the runway system.
 - 8. Provide cable radius drop out from ladder runway to vertical cable managers at every location where cables transition from the runway to the cable managers.
 - 9. Use moveable cross members where required to mount the cable radius drop out so cables can be routed directly into the vertical cable managers.

3.3 AC POWER AND GROUNDING

- A. Coordinate with electrical contractor placement of electrical outlets at specified telecom open racks, cabinets and Enclosures.
- B. Provide a Telecommunications Bonding Infrastructure compliant with the authorities having jurisdiction.
- C. Provide a PBB and SBB sized as described in Part 2 and shown on the drawings.
- D. Provide connection from all equipment racks and ladder runway within the telecommunications room, and cable tray and conduit that enter the room to the PBB or SBB.
 - 1. Provide a home run #6 CU ground wire from each equipment rack unless drawings provide alternative grounding scheme.
 - 2. Provide a home run #6 CU ground wire from each independent group of ladder runway sections.
 - 3. Provide #6 CU ground strap between ladder sections to create a single ground plane.
 - 4. Provide a home run #6 CU ground wire from any cable tray or conduit that enters the room.
 - 5. Terminate ground wire with a two-hole #6 ground lug.
 - 6. Use correctly sized compress tools
 - 7. Strip insulated ground wire in accordance with manufacturer installation instructions to ensure exposed conductors are not too long, too short or are not nicked or cut.
 - 8. Clean ground wire conductors in accordance with manufacturer installation instruction prior to installing irreversible compression connectors.
 - 9. Provide compression connectors utilizing the tool and die recommended by the compression connector manufacturer.
 - 10. Ensure the die index number is embossed on the connector barrel and the die index number is visible when the connector is installed.
 - 11. Remove any finish and make-bare any metallic surface at the point where ground wires are connected to and or terminated on equipment frames, racks, cable runway or cable tray.
 - 12. Provide joint compound for copper-to-copper and copper-to-steel connections in accordance with manufacturer installation instructions
- E. Coordinate and verify that final connection of the Equipment Grounding System for the building has been tested and accepted for use prior to connecting any portion of the Telecommunications Bonding Infrastructure to the Equipment Grounding System.
 - 1. Bond PBB to main electrical service ground with #3/0 CU insulated cable.
 - a. Terminate with two-hole #3/0 ground lug.
 - 2. Connect busbar to building structural steel with #6 CU ground wire.
 - a. Terminate with two-hole #6 ground lug.
 - 3. Use correctly sized compress tools.

3.4 FINAL INSPECTION

- A. Be cognizant of the project schedule and execute work to comply with the Project Schedule for Final Inspection.

- B. Ensure that the project management and the Architect are made aware of any issues that may prevent the completion of work prior to the scheduled final inspection time-frame.
- C. If the Contract Documents, law, ordinances, rules, regulations or orders of any public authority having jurisdiction require any Work to be inspected, tested or approved, the Contractor must give timely notice to the Owner and the Consultant of the readiness and the date arranged so they may observe such inspection, testing or approval procedure. Should the material or Work fail to comply with the requirements of the Contract Documents, the Contractor must bear all costs to replace, fix, and/or re-terminate the failed work.

END OF SECTION 27 11 00

SECTION 27 41 16 - INTEGRATED AUDIO/VIDEO SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Integrated Audio-Video Systems and Equipment as part of the Work.

1.2 RELATED DOCUMENTS

- A. General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this section.
- B. Reference the Project Manual for related specification sections.
- C. Reference the Project Drawings for additional information.

1.3 SECTION INCLUDES

- A. Project instructions for the Contractor and System description details
- B. System product description
- C. Project completion instructions for the Contractor

1.4 RESPONSIBILITY

- A. Responsibilities include, but are not limited to, the following items:
 - 1. Provide materials, equipment, transportation, and labor necessary for a fully working, tested, and calibrated system. Supply accessories and minor equipment items (such as, but not limited to, power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.
 - 2. Specifications and drawings are complementary. Work called for by one is binding as if called for by both. Any discrepancies between specifications and drawings shall be brought to the attention of the Architect for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Architect.
 - 3. Execute work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code, the Occupational Safety and Health Act (OSHA), applicable State and Local codes, ordinances, regulations, authority having jurisdiction (AHJ), and

manufacturer's recommendations. If a conflict develops between the contract documents and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform Work.

4. Required licenses, insurance and permits including payment of charges and fees
5. Verification of dimensions and conditions at the job site.
6. Coordinate location and installation of equipment with other building elements.
7. Preparation of submittal information
8. Pick-up of Owner Furnished Equipment (OFE) and incorporation into project if applicable.
9. Development and implementation of control system software code and control panel layouts, which will become the property of the Owner
10. Final tests and adjustments, written report, and documentation
11. Instruction of operating personnel
12. Provision of manuals
13. Maintenance services and warranty.

1.5 REFERENCES

- A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
1. American National Safety Institute (ANSI)
 2. American Society of Testing and Materials (ASTM)
 3. Electronics Industries Association (EIA)
 4. Federal Communications Commission (FCC)
 5. National Electrical Manufacturer's Association (NEMA)
 6. National Electrical Code (NEC)
 7. Underwriters Laboratories (UL)
 8. Occupational Safety and Health Administration (OSHA)
 9. Society of Motion Picture and Television Engineers (SMPTE)
 10. Building Industry Consulting Service International (BICSI)
 11. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
 12. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
 13. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009

1.6 DEFINITIONS

- A. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:
1. Furnish - To purchase, procure, acquire, and deliver complete with related accessories.
 2. Install – To set in place, join, attach, link, set up or otherwise connect together and test until complete before turning over to the Owner, all parts, items, or equipment supplied by Contractor.
 3. Provide – To furnish and install.

1.7 DESCRIPTIONS & REQUIREMENTS

- A. The following is intended to further describe the Work and clarify design intent and is not an exhaustive description of the systems.
- B. LOCKER ROOM
1. The locker room will be equipped with audio-visual technology to support the functions of the space and coaching staff needs.
 2. Provide multiple flat panel displays within Locker Room to support viewing of owner-furnished TV set-up boxes. Control for TVs and set-top boxes will be via manufacturer remotes.
 3. Provide a high-fidelity sound system utilizing a distributed loudspeaker system for audio playback within the locker room. Audio sources will include a local audio input plate and Bluetooth connectivity as well as a signal for the existing PA system.
 4. Provide a control system with button panel interfaces to allow users to control audio functions such as System On/Off, Source Selection, Volume Level, etc.
- C. PLAYER LOUNGE
1. Provide multiple flat panel displays within player lounge space to support viewing of video sources. The displays will be sized appropriately for viewing and will be able to support ultra-high-definition (UHD) resolution for compatibility with modern laptops and devices.
 2. Input sources could include the following:
 - a. HDMI Inputs
 - b. TV Set Top Boxes
 3. Provide a high-fidelity sound system utilizing a distributed loudspeaker system for audio playback within the lounge space. Audio sources will include those accompanying video sources, as well as local audio inputs and Bluetooth connectivity.
 4. Provide a control system with touch or button panel interfaces to allow users to control audio-visual functions such as System On/Off, Source Selection, Volume Level, etc.
- D. BATTING AREA
1. The Batting area will be equipped with audio-visual technology to support the functions of the space and coaching staff needs.
 2. Provide multiple flat panel displays within Batting area to support viewing of owner-furnished TV set-up boxes. Control for TVs and set-top boxes will be via manufacturer remotes.
 3. Provide a high-fidelity sound system utilizing a distributed loudspeaker system for audio playback within the locker room. Audio sources will include a local audio input plate and Bluetooth connectivity as well as a signal for the existing PA system.
 4. Provide a control system with button panel interfaces to allow users to control audio functions such as System On/Off, Source Selection, Volume Level, etc.
- E. Lobby
1. Provide a flat panel display within Lobby to support viewing of owner-furnished TV set-up boxes. Control for TVs and set-top boxes will be via manufacturer remotes.
- F.

1.8 SUBMITTALS

- A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.
- B. Submittals shall contain sufficient information to describe the Work to be performed. Reviewed shop drawings are to be used for final coordination and construction.
- C. Shop drawings must be original work produced by the Contractor responsible for performing the work defined in this specification. Scanning, photographic copying, materially copying, or any other reproducing the contents of the drawings or specifications contained within the Contract Documents will be marked as unacceptable and not reviewed for any content. No claim shall be made for delay, undue burden, or additional costs for the effort to produce shop drawings, schedules, and equipment lists addressing this specification or the overall project manual.
- D. Supplementary submittal requirements:
 - 1. Provide the following in one electronic submission for review within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of Work:
 - a. Complete schedule of submittals.
 - b. Chronological schedule of Work in bar chart form.
 - c. Product Data Sheets:
 - 1) Provide a complete table of contents with the following information:
 - 2) Project title.
 - 3) Submittal number. In the case of a resubmittal, use the original submittal number immediately followed by the suffix "R" immediately followed by a unique number and be numbered in consecutive order.
 - 4) Date of submission.
 - 5) Provide a list of and Manufacturer's data sheets on products to be incorporated with the Work. Arrange data sheets in the same order they appear in this specification. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.
 - 6) Submit manufacturer's product literature for each type of firestop material to be used. Literature shall include documentation of UL classifications or approved third party testing. Manufacturer's name and number for each part shall be included. Submit drawings of through penetrations, which include the system to be utilized for the firestopping application. Drawing shall indicate construction of wall or floor assembly; size, number and material of penetrating items; firestop system designation; required F-rating, T-rating and remarks.
 - 7) Upon Owners and/or Consultant's request provide (3) three copies of the submittals. Bind submittal in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three-inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.
 - 8) Submissions that do not follow the format and configuration described above will be returned without review.
 - d. Shop Drawings:

- 1) Functional Diagrams/Schematics:
 - a) Detailed wiring diagrams showing interconnection of components and products, wiring and cabling diagrams depicting cable types and designators, and device designators for each system. Provide connector designations and terminal strip identification, along with color codes for cables connecting to these devices. Give each component a unique designator and use this designator consistently throughout the project.
- 2) Coordination Drawings:
 - a) Prepare and submit a set of coordination drawings showing major elements, components, and devices of the audio and video system in relationship with other building components. Prepare drawings to an accurate scale of 1/8"=1'-0" or larger on suitable sized media.
 - b) Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all equipment. Indicate locations where space is limited, and where sequencing and coordination of installations is of importance to the efficient flow of the Work including but not necessarily limited to the following:
 - (1) Equipment housings
 - (2) Ceiling and wall mounted devices
 - (3) Raceways
 - (4) Cabling
- e. Equipment: Location of equipment within racks, consoles, or on tables, with dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations.
- f. Patch panel(s): Layouts and designation (labeling) strips, including color schemes.
- g. Full fabrication details of any custom enclosures and millwork indicating size, material, finish and openings for equipment.
- h. Structural rigging and mounting details:
 - 1) Loudspeaker rigging, suspension, and mounting detail drawings shall be signed and sealed by a professional engineer licensed to practice in the state in which the project is located. The signed and sealed drawings noted above to include the following:
 - a) Analysis of all components in the load path and attachment method to building structure for suspended loudspeakers.
 - b) Attachment method for mounting brackets at ceilings, walls, or other building features.
 - c) Detail the product manufacturer, part numbers, and load capacity of the hardware fittings and materials selected for suspended or mounted loudspeakers.
 - d) A copy of the design calculations.
 - e) Secondary steel required for attachment to the building structure.
 - f) Custom brackets, mounts, suspension grids or trusses, loudspeaker cabinet frames, or loudspeaker brackets.
 - g) Loudspeaker brackets or mounts provided by the specific loudspeaker manufacturer being installed that do not include traceability data.
 - 2) Risk analysis data as referenced in Part 3.2, F
 - 3) Stamping Engineer post-installation sign-off as described in Part 3.2, F
 - 4) Proof of ETCP certification for on-site rigging crew.

- i. Projector, loudspeaker, camera mounting details, include hardware types and load capacity.
 - j. Fabricated Plates and Panels
 - 1) Provide complete drawings on custom fabricated plates or panels. Drawings shall include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material.
 - k. Labeling
 - 1) Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.
 - l. Schedules
 - 1) Wiring schedule showing source and destination of wiring and indicating which wiring is in conduit. Junction box schedule showing type of box, size, mounting and location. Include this information with remainder of wiring diagrams.
 - m. Control System Software
 - 1) Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).
 - n. IP Addresses
 - 1) Coordinated with the venue IT Administrator, provide a list of IP addresses, by device, used in the project.
 - o. Consultant's project documents in electronic format will not be supplied to the Contractor for their use as part of submittals.
 - p. Detail drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
 - q. Submissions that do not follow the format and configuration described above will be returned without review.
 - r. Any other pertinent data which is necessary to provide the Work.
2. Control System Software:
- a. Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).

E. Resubmission requirements:

- 1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
- 2. Indicate all changes that have been made other than those requested.

1.9 CONTRACT CLOSE-OUT DOCUMENTS:

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated, after substantial completion but prior to final observation:

B. Supplementary submittal requirements:

- 1. Provide the following in one electronic submission for review.
 - a. Equipment Manuals:
 - 1) Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein
 - 2) Supply manufacturer's serial numbers for each Product

- 3) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item
 - 4) Separately bind list by manufacturer and model or part number of Products incorporated within the Work, arranged in alpha numeric order. When applicable, bind Manufacturer's warranty statements separately.
 - b. Test Reports: Recorded findings of Commissioning.
 - c. Signed copy of turn over equipment to Owner including quantity, make and model.
 - d. Copy of any program or hardware setup files.
 - e. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
 - 1) This procedure should describe the operation of system capabilities.
 - 2) Assume the intended reader of the manual to be technically inexperienced but unfamiliar with the components and the facility.
 - f. Provide Consultant with copy of Owner training video.
 - g. Service Information, including service phone number(s) and hours; service schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
 - h. Any other pertinent data generated during the Project or required for future service.
 - i. Within three (3) weeks of final observation, submit the following in one electronic submission for review. Upon Owners and/or Consultant's request provide (3) three copies of the following:
 - 1) Record drawings: Final rendition of Shop Drawings depicting what is actually incorporated within the Work.
 - 2) Hardcopy full size set of Record drawings.
 - 3) Three (3) compact disc or DVD's containing Record drawings in AutoCAD editable DWG format and Adobe PDF format. Resolution to be sufficient to permit Owner's technicians to be able to clearly read all notes and text on screen.
 - 4) One set of signed proof-of-training documents.
2. Submittal Format:
- a. Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
 - b. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g., operational data in maintenance binding.
 - c. Bind Project Record Manual in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.

C. Resubmission requirements:

1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
2. Indicate all changes that have been made other than those requested.

1.10 CUSTOM SOFTWARE

A. Introduction:

1. Proprietary software provided for the Technical Systems shall be subject to this software license between the Contractor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings and agreement.
2. Contractor shall agree that 3rd party proprietary software provided with the system shall be subject to this agreement.
3. Contractor and Owner agree that this software license is deemed to be part of, and subject to, the terms of the Agreement applicable to both parties; and shall supersede any standard manufacturer or Contractor's standard license agreement.
4. Proprietary software shall be defined to include, but not be limited to, device and system specific software and firmware designed to run on conventional computer based operating platforms as well as all micro-processor based hardware used to program, setup, or operate the system or its components.
5. For sake of this agreement, MS Windows® shall not be considered "proprietary" software, unless a non-public version of Windows® or any of its components are critical to the operation of the system in which case it shall be deemed proprietary.

B. License Grant and Ownership:

1. Contractor hereby grants to Owner a perpetual, non-exclusive, site license to all software for Customer's use in connection with the establishment, use, maintenance and modification of the system implemented by Contractor. Software shall mean executable object code of software programs and the patches, scripts, modifications, enhancements, designs, concepts or other materials that constitute the software programs necessary for the proper function and operation of the system as delivered by the Contractor and accepted by the Owner.
2. Except as expressly set forth in this agreement, Contractor shall at all times own all intellectual property rights in the software. Any and all licenses, product warranties or service contracts provided by third parties in connection with any software, hardware or other software or services provided in the system shall be delivered to Owner for the sole benefit of Owner.
3. Owner may supply to Contractor or allow the Contractor to use certain proprietary information, including service marks, logos, graphics, software, documents and business information and plans that have been authored or pre-owned by Contractor. All such intellectual property shall remain the exclusive property of Owner and shall not be used by Contractor for any purposes other than those associated with delivery of the system.

C. Copies, Modifications, and Use:

1. Source code shall be available to Owner for a period of not less than 10 years.
2. Owner may make copies of the software for archival purposes and as required for modifications to the system. All copies and distribution of the software shall remain within the direct control of Owner and its representatives.
3. Owner may make modifications to the source code version of the software, if and only if the results of all such modifications are applied solely to the system. In no way does this Software License confer any right for Owner to license, sublicense, sell, or otherwise authorize the use of the software, whether in executable form, source code or otherwise, by any third parties.
4. All express or implied warranties relating to the software shall be deemed null and void in case of any modification to the software made by any party other than Contractor.

D. Warranties and Representations:

1. Contractor represents and warrants to Owner that:
 - a. It has all necessary rights and authority to execute and deliver this Software License and perform its obligations hereunder and to grant the rights granted under this Software License to Owner;
 - b. The goods and services provided by contractor under this Software License, including the software and all intellectual property provided hereunder, are original to Contractor or its subcontractors or partners; and
 - c. The software, as delivered as part of the system, will not infringe or otherwise violate the rights of any third party, or violate any applicable law, rule or regulation.
2. Contractor further represents and warrants that, throughout the System Warranty Period, the executable object code of software and the system will perform substantially in accordance with the System Specifications and Agreement. If the software fails to perform as specified and accepted all remedies are pursuant to the policies set forth in the Specification and in the Agreement. No warranty of any type or nature is provided for the source code version of the software which is delivered as is.
3. Except as expressly stated in this Agreement, there are no warranties, express or implied, including, but not limited to, the implied warranties of fitness for a particular purpose, of merchantability, or warranty of no infringement of third party intellectual property rights.

1.11 QUALITY ASSURANCE

- A. Qualifications: Contractor to be experienced in the provision of systems similar in complexity to those required for this project, and meet the requirements listed below. Provide documentation at the time of bid to support these qualifications:
 1. Form of corporation.
 2. No less than three years' experience with equipment and systems of the specified types.
 3. Experience with at least three comparable scale projects within the last three years.
 4. Be a franchised dealer and service facility for the manufacturer's products furnished.
 5. Maintain a fully staffed and equipped service facility with full-time field technicians.
 6. Have at least one supervisory on-site employee who has completed and has been certified CTS-I by Infocomm.
 7. Supervision of all rigging by an ETCP certified rigger for all work associated with suspension or mounting of overhead equipment.
 8. Adequate plant capacity and equipment to complete the Work.
 9. Adequate staff with commensurate technical experience.
 10. Suitable financial status (i.e., bonding and materials purchase capacity) to meet the obligations of the Work.
 11. Adequate regional service organization to meet warranty response requirements of the Project.
 12. Provide listing with appropriate explanation regarding the status of Contractor's resolved or unresolved legal disputes within the last six calendar years.
 13. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Contractor has failed to meet construction schedules due to Contractor's cause.
 14. Completed current version of the AIA Contractor's Qualification Form.
- B. Subcontractors: at the time of bid, the Contractor shall provide a list of structural, electrical, sound, or any other subcontractors intended to do the Work, or are being retained as local

service providers throughout the warranty period. Subcontractors shall be appropriately state licensed in their specialty and must provide the same qualification documents as the Contractor.

- C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
 - 1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
 - 2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
 - 3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.
- D. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Architect.

1.12 DELIVERY, STORAGE & HANDLING

- A. Ship Products in its original container, to prevent damaging or entrance of foreign matter.
- B. Handling and shipping in accordance with Manufacturer's recommendation.
- C. Provide protective covering during construction of all installed devices, to prevent damaging or entrance of foreign matter.
- D. Replace at no expense to Owner, Products damaged during storage, handling or the course of construction.

1.13 PROJECT CONDITIONS

- A. Verify conditions on the job site applicable to this work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to Architect for approval, showing how the work may be installed.

1.14 WARRANTY

- A. Warrant labor and equipment for one year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or equipment within the Warranty period without charge.

- B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.
- C. Within the warranty period, answer service calls within twenty four (24) hours during normal working hours and correct the deficiency within forty eight (48) hours.
- D. Provide Owner with the name and telephone number of the person to call for service. This information to be part of Project Closeout Documents.
- E. Thirty days prior to the end of the warranty period provide a complete checkout of all system components. Repair or replace any defective equipment discovered during the testing. Correct any defects in wiring or other functional problems reported by Owner. Warranty replacement and service of equipment shall not apply to Owner furnished equipment (OFE). Coordinate observation visit with the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Products quantity is as required. If a quantity is given, provide at least the given amount. Some product listed may not be required to fulfill the obligations of the Work.
- B. Equipment and materials shall be new and conform to applicable UL or ANSI provisions.
- C. Regardless of the length or completeness of the descriptive paragraph herein, provide Products complying with the specified manufacturer's published specifications.
- D. Remove or blank out all manufacturers' names, logos, or other symbols from loudspeakers or other objects placed in view of the public. If logos are removable, remove and repaint to the color of the adjacent surface and reattach.
- E. Take care during installation to prevent scratches, dents, chips, etc.

2.2 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers included in this specification are listed as a standard of function, performance, and quality.
- B. Refer to General and Supplementary Conditions and Division 1 Specification Sections for equipment substitution procedure.

- C. If a specified product has been discontinued by a manufacturer, provide the replacement model (as certified by the manufacturer) at no additional cost.
- D. Where required provide manufacturer's rack mount adapter or one manufactured by Middle Atlantic or Winstead unless specified elsewhere.

2.3 INPUT SOURCES

A. Bluetooth with Analog Input Plate (BT, Type1):

- 1. Bluetooth, RCA, and 3.5MM inputs
- 2. 3.5MM outputs
- 3. Dante/AES67 connectivity
- 4. 2-gang Decora style
- 5. Acceptable Product:
 - a. Atterotech unD6IO-BT

2.4 DIGITAL SIGNAL PROCESSORS

- A. Signal processing shall be performed by a computer-based system.
- B. The DSP system shall be fully operational 60 days prior to the first use of the installed system.
- C. The system shall have the following capabilities:
 - 1. Digital Signal Processing Unit:
 - a. Interior configuration of signal flow and routing to be fully user configurable
 - b. Unit to permit hardwire connection of external switches for recalling presets
 - c. Unit to have no external user adjustable controls
 - d. Dante compatible
 - e. Acceptable Product to include the following:
 - 1) QSC QSYS Core 110f (DSP, Type 1)
 - 2) QSC SLDAN-8-P (8 x 8 soft Dante)
 - 3) QSC SLDAN-16-P (16 x 16 soft Dante)
 - 4) QSC SLDAN-32-P (32 x 32 soft Dante)
 - 5) QSC SLQSE-110-P
 - 6) QSC SLQUD-110-P

2.5 POWER AMPLIFIERS

A. Power Amplifiers:

- 1. Provide protection of circuit components in the event of input over-drive, output overload, or short circuits
- 2. Frequency response: ± 1 dB, 20 Hz to 20 kHz with less than 1 percent THD at rated output
- 3. Input impedance: 10 kohms balanced

4. Output regulation: 2 dB from no load to full load conditions
5. Noise generation: at least 85 dB below rated output with input shorted
6. Ventilation: variable speed fans that shut off when the amplifier is operating under light or no-load conditions
7. Bowl System: adequate power supply capacity to maintain DSP power through emergency power take over, should building power be lost. Or, provide adequate UPS to maintain amplifiers needed for sustaining intelligibility standards through emergency power take over, should building power be lost.
8. Acceptable Products:
 - a. Type 1 Power Amplifier: - 8 Channel, 300 Watts Continuous per Channel at 70V/8 Ohms:
 - 1) QSC CX-Q 4K8
 - b. Type 2 Power Amplifier: - 8 Channel, 600 Watts Continuous per Channel at 70V/8 Ohms:
 - 1) QSC CX-Q 8K8

2.6 LOUDSPEAKERS

A. Type 1 Loudspeakers:

1. 6.5-inch coaxial in-ceiling loudspeaker
2. 110-degree conical coverage
3. 16 Ohm or 70V selectable with tap points at 60W, 30W, 15W, 7.5W
4. 88dB 1Watt/1meter Sensitivity
5. 107dB Peak SPL
6. Acceptable Product:
 - a. JBL Control 26CT

B. Type 2 Loudspeakers:

1. 8-inch High-Impact In-Ceiling Subwoofer
2. 8 Ohm or 70V selectable with tap points at 80W, 40W, 20W, 10W
3. 95dB 1Watt/1meter Sensitivity
4. 108dB Peak SPL
5. Acceptable Product:
 - a. JBL Control 40CST

C. Type 3 Loudspeakers:

1. Compact Full-Range Pendant Loudspeaker
2. 120-degree conical coverage
3. 8 Ohm or 70V selectable with tap points at 60W, 30W, 15W, 7.5W
4. 88dB 1Watt/1meter Sensitivity
5. 105dB Peak SPL
6. Acceptable Product:
 - a. JBL Control 26CT

D. Type 4 Loudspeakers:

1. Pendant Subwoofer with Crossover
2. 8 Ohm or 70V selectable with tap points at 110W, 55W, 30W, 15W

3. 88dB 1Watt/1meter Sensitivity
4. 107dB Peak SPL
5. Acceptable Product:
 - a. JBL Control 60PST

E. Type 5 Loudspeakers:

1. Extended Range Full-Range Pendant Speaker
2. 120-degree conical coverage
3. 8 Ohm or 70V selectable with tap points at 60W, 30W, 15W, 7.5W
4. 90dB 1Watt/1meter Sensitivity
5. 109dB Peak SPL
6. Acceptable Product:
 - a. JBL Control 67PT

F. Type 6 Loudspeakers:

1. Pendant Subwoofer with Crossover
2. 8 Ohm or 70V selectable with tap points at 110W, 55W, 30W, 15W
3. 88dB 1Watt/1meter Sensitivity
4. 107dB Peak SPL
5. Acceptable Product:
 - a. JBL Control 60PST

2.7 VIDEO DISPLAYS

A. 43" Display:

1. Provide Commercial Grade LCD UHD TV Display
2. Native Resolution 3840 x 2160
3. RS232C Control Input
4. Two (2) HDMI/HDCP Inputs
5. USB 2.0 Inputs
6. VESA Standard Mount
7. Acceptable Product:
 - a. Samsung QB43B w/ Chief MTM1U

B. 50" Display:

1. Provide Commercial Grade LCD UHD TV Display
2. Native Resolution 3840 x 2160
3. RS232C Control Input
4. Two (2) HDMI/HDCP Inputs
5. USB 2.0 Inputs
6. VESA Standard Mount
7. Acceptable Product:
 - a. Samsung QB50B w/ Chief LTM1U

C. 55" Display:

1. Provide Commercial Grade LCD UHD TV Display
2. Native Resolution 3840 x 2160

3. RS232C Control Input
4. Two (2) HDMI/HDCP Inputs
5. USB 2.0 Inputs
6. VESA Standard Mount
7. Acceptable Product:
 - a. Samsung QB55B w/ Chief LTM1U

D. 65" Display:

1. Provide Commercial Grade LCD UHD TV Display
2. Native Resolution 3840 x 2160
3. RS232C Control Input
4. Two (2) HDMI/HDCP Inputs
5. USB 2.0 Inputs
6. VESA Standard Mount
7. Acceptable Product:
 - a. Samsung QB65B w/ Chief LTM1U

E. 75" Display:

1. Provide Commercial Grade LCD UHD TV Display
2. Native Resolution 3840 x 2160
3. RS232C Control Input
4. Two (2) HDMI/HDCP Inputs
5. USB 2.0 Inputs
6. VESA Standard Mount
7. Acceptable Product:
 - a. Samsung QB75B w/ Chief LTM1U

2.8 AV SOURCES

A. TV SET-TOP BOX (TV-SET, Type 1)

1. Owner-Furnished TV set top box.

B. AppleTV Player (APPLE, Type 1)

1. Acceptable Product
 - a. Apple TV 4k 64GB

C. Music Player (Music, Type 1)

1. 4 stereo zones of network music replay
2. Integration with local network content storage
3. PC/Mac, iOS/Android and third-party control
4. Security preventing unauthorized control
5. Replay from locally connected USB drives
6. Streaming via ethernet for increased reliability
7. Seamless Integration with Control Systems.
8. Acceptable Product
 - a. Bluesound-Professional B400S

2.9 TRANSMITTERS/RECEIVERS

A. DM Transmitter Wall Plate (DMTX, Type 1):

1. Converts HDMI to CAT5e/6.
2. Available in black or white. Color to be selected by Architect.
3. Acceptable Product:
 - a. Crestron DM-TX-4KZ-100-C-1G

2.10 ENCODERS/DECODERS

A. Streaming Transport Chassis (CHASSIS, Type 1):

1. DM Card Chassis
2. 8 slot, rack-mounted solution for DM-NVX-C & DMCF
3. 2-space 19-inch rack-mountable
4. Provide as many Chassis needed per AV Equipment Rack. Reference AV drawings.
5. Acceptable Product:
 - a. Crestron DMF-CI-8

B. Streaming Transport Encoder Card with DM Input (ENCODER, Type 1)

1. 4K60 4:4:4 video over standard Gigabit Ethernet
2. Encoder functionality for use with DM NVX products that can function as decoders
3. DM input for interoperability with DM 8G+ output devices and DM Lite transmitters, including DM 8G+ and DM Lite wall plate transmitters
4. Acceptable Product:
 - a. Crestron DM-NVX-E760C

C. Streaming Transport Encoder Card (ENCODER, Type 2)

1. 4K60 4:4:4 HDR Network AV Encoder Card
2. HDR10, HDR10+, and Dolby Vision video support
3. Encoder functionality for use with DM NVX products that can function as decoders
4. Acceptable Product:
 - a. Crestron DM-NVX-E30C

D. Streaming Transport Encoder/Decoder (DECODER, Type 1)

1. 4K60 4:4:4 video over standard Gigabit Ethernet
2. HDR10, HDR10+, and Dolby Vision video support
3. Dante or AES67 audio embedding and de-embedding
4. Acceptable Product:
 - a. Crestron DM-NVX-363

2.11 AV NETWORK HARDWARE

A. Ethernet Switch (AV SWITCH, Type 1):

1. 1-GB Ports
2. Nonblocking backplane
3. Layer 3

4. IGMP implementation
5. Sufficient bandwidth uplinks for all AV over IP encoders and decoders
6. PoE and PoE+ ports
7. Compatible and approved by DSP and amplifier system manufacturer
8. Provide Fiber Optic adaptors as required
9. Recess switch into rack far enough to cover with a blank panel
10. Provide label on blank cover stating "Priority Communications System Only"
11. Compliant with venue IT Standards
12. Acceptable Product:
 - a. Netgear M4250 series
 - b. Luxul AV-Series
 - c. Cisco Catalyst 9300 series

2.12 CONTROL SYSTEM

A. Control System (CP, Type 1)

1. 4-Series Control Engine
2. Ports: RS232/422/485
3. Eight relays
4. Eight I/O channels
5. Supports up to 10 simultaneously running programs
6. Acceptable Product to include:
 - a. Crestron CP4N

2.13 USER INTERFACES

A. Touch Panel (TP, Type 1):

1. 10.1 in. (257 mm) widescreen active-matrix color display and 1920 x 1200 WUXGA display resolution
2. Capacitive touch screen display
3. Built-in speakers and microphone
4. H.265, H.264, or MJPEG streaming video display
5. Built-in Bluetooth communications beacon
6. Built-in web browsing
7. Single wire Ethernet connection with PoE or PoE+ power
8. Dual USB 2.0 ports for room availability accessories
9. Acceptable Product:
 - a. Crestron TSW-1070-B-S

2.14 POWER SYSTEMS

A. Power Protection:

1. Provide surge protection devices to maintain clean power to the following equipment:
 - a. All computer CPU's and associated video monitors
 - b. All Audio System Network equipment
 - c. All low level (mic or line) processing equipment with internal microprocessor or DSP chips

- A. Configure equipment racks for proper airflow and cooling
- B. Middle Atlantic systems listed below are approved for use on this project and are listed to set the acceptable standard of performance. Equipment housing systems from Lowell or other approved equivalents are also acceptable provided they meet the performance specifications of the approved listed equipment housing systems.
- C. Equipment Racks:
 - 1. Type: Frame and panel with locking rear door
 - 2. Size: 36-inches deep with 44 units of vertical space
 - 3. Construction: Factory assembled 16-gauge cold-rolled steel frames with all corners welded
 - 4. Black enameled finish
 - 5. Provide all necessary side panels, trim pieces, tops, and blank panels
 - 6. Provide Middle Atlantic VBK-W27-W32 Vent Blocker kit(s) and configure for proper airflow and cooling of rack
 - 7. Acceptable Product:
 - a. Middle Atlantic Products MRK series
- D. Rack Drawer:
 - 1. Spring loaded latch
 - 2. Black textured finish
 - 3. Acceptable Product:
 - a. Middle Atlantic TD series
- E. Low Profile Keyboard Shelf:
 - 1. Sliding black laminate shelf
 - 2. Single rack space
 - 3. Acceptable Product:
 - a. Middle Atlantic SSL
- F. Computer Shelf:
 - 1. Flanged construction
 - 2. 16 Gauge steel
 - 3. Black powder coat finish
 - 4. Acceptable Product:
 - a. Middle Atlantic U4
- G. Universal Rack Shelf:
 - 1. Black textured powder coat finish
 - 2. Acceptable Product:
 - a. Middle Atlantic RSU-129
- H. Universal Mounting Trays:
 - 1. Multiple Devices

2. Acceptable Product:
 - a. Extron RSU 126
 3. Single Device
 4. Acceptable Product:
 - a. Extron RSB 126
- I. Blank Rack Panels:
1. Flanged construction
 2. 16 Gauge steel
 3. Black powder coat finish
 4. Acceptable Product:
 - a. Middle Atlantic SB series
- J. Vent Rack Panels:
1. Flanged construction
 2. 16 Gauge steel
 3. Black powder coat finish
 4. Acceptable Product:
 - a. Middle Atlantic VTF series
- K. Rack Fan:
1. 10" or 4.5"(x4), 115V
 2. Include cord and hardware
 3. Acceptable Product:
 - a. Middle Atlantic FAN10 with GUARD-10
 - b. Middle Atlantic FAN with GUARD
- L. Fan Thermostat Control:
1. Switched 15A duplex outlet
 2. Temperature Range: 50 – 90 Degrees
 3. On and Stand-by LED indicators
 4. Integral mounting ears
 5. Provide for each rack fan assembly
 6. Acceptable Product:
 - a. Middle Atlantic FC-4-1C
- M. Rack Temperature Display:
1. Provide one display in top front panel space of each rack
 2. Decora mount in 1-RU rack panel
 3. Digital readout in Fahrenheit or Celsius
 4. Connect to DAP GPIO for high temperature alarm to the Audio Control Booth
 5. Acceptable Products:
 - a. Middle Atlantic TEMP-DEC with DECP-1X1 Panel.
- N. Rack Light:
1. Provide 60W incandescent or 13W fluorescent work light
 2. Located in all equipment racks over 36 RU's high

3. Acceptable Product:
 - a. Middle Atlantic WL-60
 - b. Lowell RL-1

O. Copper Bus Bars:

1. Material: Solid copper, 1/8 thick and 2-inches wide with threaded 10/32 holes
2. Height: 70-inch for 40-RU or larger racks and 21-inch for racks under 40-RU
3. Wire each circuit ground to bus bar and isolated outlet ground
4. Terminate two #6 wires between rack and buss bar
5. Provide with nylon isolation mounts
6. Provide one bus bar in each rack
7. Acceptable Product:
 - a. Middle Atlantic BB-40
 - b. Middle Atlantic BB-12

P. Equipment Rack Screws:

1. Install rack mounted equipment with black 10-32 star post security screws with flat nylon washers
2. Quantity as required
3. Provide one spare bit located in a clear plastic bag attached to the inside of each equipment rack in plain view
4. Acceptable Product:
 - a. Middle Atlantic HTX
 - b. Raxxess PNTX

Q. Wire Duct:

1. Purpose: signal wire routing in rack
2. Acceptable Product:
 - a. Panduit Type E Slotted

R. Surface Mount Wire Duct:

1. Signal level cabling, loudspeaker level cabling, electrical
2. Acceptable Product:
 - a. Wiremold 4000 Series

2.16 PLATES AND PANELS

- A. Provide plates and panels and as described in Drawings. Engrave as shown on Drawings. Other Plates and Panels may be required to satisfy the requirements of the Work.
- B. Custom panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.
- C. Plate finish shall be coordinated with the Architect. Plastic plates are not acceptable.

- D. Panel, plate, and label engraving shall be 1/8-inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum pushbuttons, letters shall be black.
- E. Custom and/or Engraved Panels:
 - 1. Custom panels constructed of 1/8-inch brushed aluminum
 - 2. Finish: black anodize
 - 3. Acceptable Product:
 - a. RCI Custom
 - b. ProCo
 - c. Whirlwind
- F. Patch Panels for Audio/Video plate tie lines:
 - 1. Flat all-metal Shielded modular patch panels
 - 2. Mounts to standard cabinets and EIA 19" Racks
 - 3. 16-ports per 1U panel
 - 4. Strain relief bar includes cable tie slots for managing and supporting cables
 - 5. Label area to correspond to unique ID number of AV, AVC, FB plates (Labels to be printed, not hand-written)
 - 6. Utilizes Mini-Com Shielded snap-in modules
 - 7. Acceptable Product to include:
 - a. Panduit #CP16WSBLY
 - b. Panduit TX6 10Gig Shielded Modules
 - c. Mounting screws as needed

2.17 CABLES & WIRING

- A. All electrical conductors installed under this contract, except where otherwise specified, shall be soft drawn annealed stranded copper having a conductivity of not less than 98% of pure copper, and meet appropriate ratings (e.g., CMR, CMP, etc.)
- B. Cable shall carry appropriate fire rating (e.g., CMR, CMP, OFNR, OFNP, etc.) on jacket of cable.
- C. Where cables are routed through cable tray, provide tray rated cable of equal specification.
- D. Where speaker cables are run exposed through a return air plenum, provide plenum rated cable of equal specification.
- E. Where cabling is run through in-grade pathways, provide direct burial cable, underground rated, or cable treated with water blocking. Adjust conduit sizes accordingly to accommodate larger diameter cable.
- F. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

G. The Belden cables listed below are approved for use on this project and are listed to set the acceptable standard of performance. If field conditions or actual cable pathway requires tray or plenum cable, provide version of cable that meets required rating. Cables from Liberty, Commscope, Gepeco, Clark, Windy City, and West Penn are also acceptable provided they meet the performance specifications of the approved listed cables.

H. Loudspeaker Cables:

1. Amplifier to Rack Room Terminals:
 - a. Distance not to exceed 25 feet.
 - b. 12 gauge twisted pair, jacketed.
 - c. Acceptable Product:
 - 1) Belden 5000UP
2. Rack Room Terminals to Junction Box Terminals near loudspeaker, low impedance:
 - a. 10 gauge twisted pair, jacketed.
 - b. Acceptable Product:
 - 1) Non-Plenum: Belden 5T00UP
 - 2) Plenum: Belden 6T00UP
 - 3) In-grade: Belden 1313A
3. Rack Room Terminals to Junction Box Terminals near loudspeaker, 70V Zones:
 - a. 12 gauge twisted pair, jacketed.
 - b. Acceptable Product:
 - 1) Non-Plenum: Belden 5000UP
 - 2) Plenum: Belden 6000UE
 - 3) In-grade: Belden 1311A
4. Drop cable from Junction Box Terminals to Loudspeaker Array:
 - a. Eight conductors, 10 gauge, twisted pairs, SOOW rubber jacketed.
 - b. Acceptable Product:
 - 1) General Cable-Carrol 09008
5. Junction Box Terminals to Loudspeaker:
 - a. Distance not to exceed 15 feet.
 - b. 12 gauge, twisted pairs, SOOW rubber jacketed.
 - c. Acceptable Product:
 - 1) General Cable-Carrol 02724 (two-conductor)
 - 2) General Cable-Carrol 02726 (four-conductor)
 - 3) General Cable-Carrol 09208 (eight conductor)

I. Ethernet Cable:

1. Category 6 non-bonded pairs
2. Acceptable Product:
 - a. Non-Plenum / Riser: Belden 2412
 - b. Plenum: Belden 1352A
 - c. In-grade: Belden OSP6F
 - d. Tactical: Belden 1303E

J. Fiber Optic Cable:

1. Armored Single Mode Fiber Optic Cable
2. Acceptable Product:

- a. 6 Strand:
 - 1) Non-Plenum / Riser: Belden FDSH0065F
 - 2) Plenum / In-grade: Belden FDSD006A9
- b. 12 Strand:
 - 1) Non-Plenum / Riser: Belden FDSH0125F
 - 2) Plenum / In-grade: Belden FDSD012A9
- c. 24 Strand:
 - 1) Non-Plenum / Riser: Belden FDSH0245F
 - 2) Plenum / In-grade: Belden FDSD024A9
- d. 48 Strand:
 - 1) Non-Plenum / Riser: Belden FDSH048AK
 - 2) Plenum / In-grade: Belden FDSD048AK

K. Category 6A Patch Cables:

- 1. Rack Patch Cables
- 2. Length as required
- 3. Acceptable Product:
 - a. Belden 10GX UTP LSZH series

L. Fiber Patch Cables:

- 1. Rack Patch Cables
- 2. Length as required
- 3. Connector type as required
- 4. Acceptable Product:
 - a. Belden FP series

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate incorporation of the Work specified herein with other project work so as to facilitate a cohesive final Products.
- B. The installation recommendations contained within ASDI and Telecommunications Distribution Methods Manual are mandatory minimum standards and requirements.
- C. Mount equipment and enclosures plumb and level.
- D. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.
- E. Verify all locations of equipment in all rooms with Owner's Representative, Owner, and Consultant.

3.2 INSTALLATION

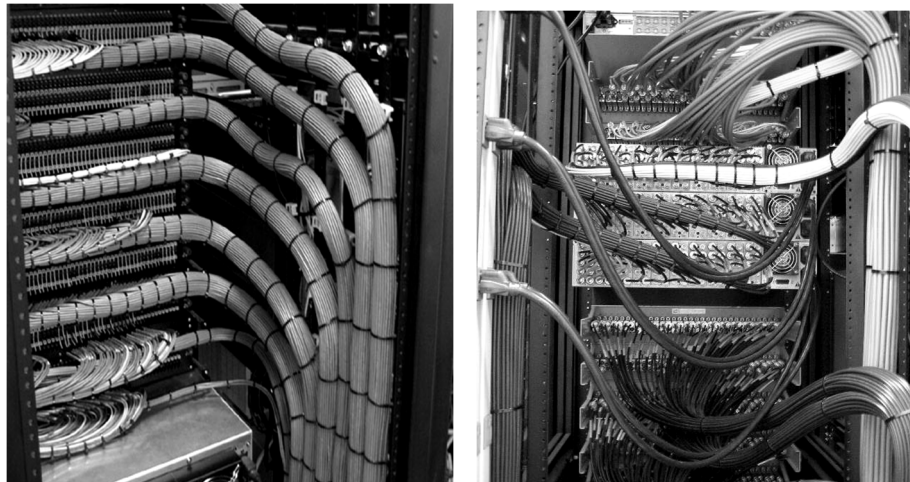
A. Installation of cable and wiring

1. Cabling and Wiring:

- a. Install cable in a manner to adhere to manufacturer's specifications for maximum cable pulling tension, minimum bend radius, and restrictions.
- b. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
- c. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of 48-inch (1.2 meter) intervals. At no point shall the cables rest on light fixtures, acoustic ceiling grids, panels, conduits, sprinkler pipe, water pipe and/or HVAC system ducting.
- d. Horizontal distribution cables shall be bundled in groups of no more than 50 cables when being supported by J-Hook or trapeze systems. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance. An exception to this rule is when cable is installed in cable tray systems.
- e. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices
- f. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.
- g. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.
- h. Cables shall be identified by a self-adhesive machine label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
- i. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- j. Provide splice free wiring and cabling from origination to destination. Cables shall be installed in continuous lengths from origin to destination (no splices). Properly designed transition points, or consolidation points are not considered 'splice' points.
- k. Make joints and connections with rosin-core 60/40 solder or with mechanical connectors specifically intended for the type and class of cable being used. Where spade lugs are used, crimp properly with ratchet type tool.
- l. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at one end. Shield not connected to be folded back over cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.
- m. Isolate cables and wires of different signals or different levels; and separate, organize, and route to restrict channel crosstalk or feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.
- n. Connect cable to active components through XLR connections whenever multiple formats are available. Make connections to speaker transformers with properly

sized closed end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.

- o. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommeting.
 - p. Execute wiring in strict adherence to:
 - 1) Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.
 - 2) Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.
 - 3) AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm, 2009
2. Equipment Housing Cabling and Wiring:
- a. Lace, tie, or harness wire or cable as required herein, and in accordance with accepted professional practice. Dress, lace or harness all wire or cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Reference photos below for standard of quality.



- b. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out, to their locked position without straining cable.
 - c. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.
 - d. Provide plastic cable ties or Velcro straps to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.
 - e. Install with connections completely visible and labeled.
 - f. Provide termination resistors, if required, of 5 per cent tolerance; fully visible and not concealed.
- B. Installation of connectors, plates & panels:
- 1. Install panel mounted connectors rigidly attached to panels, plumb and level.

2. Custom rack panels shall be 1/8 inch thick aluminum, standard EIA sizes, brushed black anodized finish (brushed in direction of aluminum grain only), unless otherwise noted.
3. Custom connector plates (speaker, microphone, etc.) are typically stainless steel, unless otherwise noted or specified. However, verify plate finish with Architect.
4. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).
5. Other Plates and Panels may be required to satisfy the requirements of the Work.

C. Installation power and grounding:

1. Coordinate final connection of power and ground wiring to housings.
2. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
3. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing. Provide a minimum of two spare outlets in each rack.
4. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three wire power cord to these busses using 6/32 nuts, bolts and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.
5. Replace manufacturers supplied 18 gauge IEC power cords with UL listed 18 gauge pre-molded 6", 12", 18", or 24". Use minimum length required. No looped or cable tied IEC power cords will be permitted within the equipment rack.
6. Replace manufacturers supplied 14 gauge IEC power cords with UL listed 14 gauge pre-molded 18" or 36" for all equipment IEC capable. Use minimum length required and minimize looped or cable tied IEC power cords present in the equipment rack.

D. Installation of electronic equipment:

1. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
2. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
3. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamicoïd labels.
4. Mount equipment plumb and level, firmly and safely held in place.

E. Installation of equipment housing:

1. Mount equipment in racks and consoles and fully wire and test before delivery to job site. If field conditions prevent prior assembly of racks, notify Owner in writing that racks will be fabricated on site and the reasons for the change.
2. Secure rack mounted devices utilizing all available fastener mounting positions on device.
3. Provide rear support for housing mounted equipment greater than 15 inches deep.
4. Provide blank panels to fill unused panel space within the equipment housing.
5. If Key door locks are required, key each housing type alike.
6. Looking at the rack from the rear, locate AC power and speaker wiring on the left; line level audio, video, and RF wiring on the right.

7. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.
8. If forced air active thermal management is used, provide ventilation blocking material on the front, sides, and rear of the equipment rack as needed. Reference Middle Atlantic Products “Controlling the Temperature Inside Equipment Racks”.
9. Panels or equipment mounted on the rear rack rails shall not block access to any front mounted components.
10. If equipment rack is not equipped with casters, provide two inch high wood base to isolate equipment rack from floor. Wood base should be capable of supporting the load.

F. Installation of loudspeakers:

1. The Contractor is responsible for final design and engineering of loudspeaker rigging, attachments, brackets, and hoisting.
2. Loudspeakers shall be mounted at the operating position in a safe, secure, and permanent manner.
3. Provide custom rigging as needed.
4. Suspension and Mounting:
 - a. Static and dynamic equipment loads shall be suspended or mounted in compliance with the following ANSI/ESTA standards, using the latest available versions of the standards:
 - 1) ANSI E1.4-2-2021 Statically Suspended Rigging Systems
 - 2) ANSI E1.56-2018 Rigging Support Points
 - 3) ANSI E1.6-1-2021 Powered Hoist Systems
 - 4) ANSI E1.8-2012 Loudspeaker Enclosures Intended for Overhead Suspension
 - b. Rigging, mounting, and support systems for overhead suspended loudspeakers shall be reviewed and certified by a registered Professional Engineer (PE), in the employ of the Contractor, licensed to practice in the State in which the project is located. Documentation shall be included as a submittal item. Once the systems are installed, the PE shall physically inspect, at the Contractor’s cost, the methods and means used to verify compliance with the original design.
5. General Guidelines:
 - a. Paint loudspeakers, supports, and related hardware color as directed by the Owner.
 - b. The aiming direction of all loudspeakers shall be adjustable by no less than ± 5 degrees horizontally and vertically.
 - c. Loudspeakers are to be oriented parallel to their mounting surface unless otherwise noted.
 - d. Provide a safety cable connected to a secondary location for each loudspeaker.
 - e. All loudspeakers located in ceiling tiles shall be located in the center of the tile unless noted otherwise.
 - f. Paint loudspeakers to match surroundings. Confirm color selection with the Architect during the submittal phase.
 - g. Exterior loudspeaker cabinets shall be constructed of materials designed for permanent outdoor exposure conditions with a minimum IP 54 rating, and a minimum expected 10-year life span. Exterior and interior surfaces of the cabinets shall be protected from the effects of water, moisture, and humidity. The exterior surface shall also be protected from the effects of ultraviolet radiation to prevent fading and color change. The cabinets shall be shaped and oriented in a manner that minimizes the possibility of water pooling on any cabinet surface. Associated

hardware shall be inherently non-corrosive, performing to the standards of 304 Stainless Steel or higher.

G. Installation of projectors:

1. Confirm distance of specified projection lens before mounting projector.
2. Projectors shall be mounted plumb and level at the operating position in a safe, secure and permanent manner.
3. All hardware required to locate the mount and projector at the required location shall be provided.
4. Projectors shall be mounted using tamper proof secure hardware.
5. Contractor may be required to adjust projection screen and lift upper and lower limit switches for projection screens and lifts specified elsewhere and not installed as part of this Contract.

H. Installation of flat panel monitors:

1. Confirm location before mounting.
2. Monitors shall be mounted plumb and level at the operating position in a safe, secure and permanent manner.
3. All hardware required to locate the mount and monitor at the required position shall be provided.
4. Locate monitor on the center line of the room unless noted otherwise.

I. Loose Equipment

1. Provide loose equipment as indicated on drawings.
2. Unpackage and assemble items.
3. Place items in designated storage or refer to Owner for direction on final location and storage of loose equipment.

3.3 FIRESTOP

- A. A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire-stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped.
- C. Fire-stop systems shall be reviewed by a Professional Engineer (PE) licensed to practice in the State in which the project is located. Stamped drawings showing the fire stop systems shall be included as a submittal item. Once the systems are installed, the engineer of record for the firestop system shall physically inspect the methods and means used to verify compliance with the original design.

- D. A drawing showing the proposed fire-stop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).
- E. All fire-stop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for observation by the local authorities prior to cable system acceptance.

3.4 CONTROL SYSTEM PROGRAMMING

A. Transport Control

1. Provide standard Stop, Play, Pause, Fast Forward and Rewind for each playback device and menu control for DVD players. Buttons should be arranged in a conventional fashion that will be familiar to the normal user.
2. The selected control function should be displayed by showing the appropriate button "pressed". It should remain this way until another function is selected.
3. For devices that will go into a standby mode after a period of time, the control system shall sense this mode and restore normal operating mode once a transport function has been selected. This may require the use of current sensors to determine the state of the unit. No direct user action should be required at the playback device to restore the normal operating mode.

B. Screen/Shade Control

1. In addition to up-down functions, provide a Stop function to allow the movement to be halted. Once movement has been stopped, the up or down buttons should resume travel in the selected direction.
2. Control system shall not prevent screen/shade wall controls from being used as well.
3. Touch panel controls should be readily accessible to the user to permit direct control of shades or screen with having to navigate through multiple control pages.

C. Room Combining

1. Combining of adjacent areas shall be done through a graphical representation of the physical areas to be combined. Use of a floor plan metaphor is recommended with the graphic oriented correctly with respect to control panel location.
2. Use buttons or other appropriate objects placed along the common wall to enable the combining function.
3. When spaces are combined, the graphic appearance of those areas shall change to reflect this configuration. Once an area is separated from a combination, the color of its area should revert to the normal room color.
4. Common control functions between combined rooms shall be linked, allowing control of the combined area from any one of the touch panels. Examples of common functions include:
 - a. Background music selection,
 - b. Background music volume
 - c. Background music muting
 - d. Lighting preset recall
 - e. Master volume (not individual channel volume)

5. When combining adjacent rooms, the control system shall force the common functions to a predetermined default configuration so all rooms have the same configuration.
6. To avoid unintentional changes, a control panel will not be able to operate a function in a remote location without also operating that same function in the room where the panel is located.

D. Level Control

1. Objects requiring level adjustment such as volume or tone controls shall be through Up/Down buttons with a graphical representation of the actual level.
2. Increment of level change to be adjusted for reasonable range without the need to push the Up or Down buttons needlessly.

E. Volume Mute

1. Where the ability to mute the sound is needed, the button shall use the label “Vol On” and “VOL OFF” instead of Mute and Unmute. When in a “VOL OFF” mode, pushing the “VOL UP” button shall restore the sound and bring the system out of the muted mode.
2. VOL ON/OFF buttons shall change color to indicate the status of the button.

F. Standard Colors

1. Control functions shall be color coded to add clarity and show relationships between different groups of controls.
2. The color Red shall be reserved to indicate a fault or abnormal condition.
3. Green may be used to indicate normal operation, but may be used for standard control colors as well.
4. Similar controls should maintain the same color scheme across all control pages.
5. When a function is selected, the graphical depiction of that button should appear to be pressed and its color change to a darker shade of the regular button color.
6. Color schemes used for background and foreground objects should be selected to be complimentary and provide a consistent theme throughout the control pages.

G. Minimum Button Size and Placement

1. Minimum visual size of a button is 3/8” wide by 1/4” high.
2. Spacing between buttons should be no less than 1/16”.
3. Where buttons are immediately adjacent, the active selection area of the button should be reduced to 80% of the visual area of the button.

H. Button Actions

1. When a function on a control page is selected, that button or visual object associated with that function should change to reflect what has been chosen.
2. For functions that are momentary selections (i.e., VOL UP), the change of state is visible for as long as the button is being pressed.
3. For function that are maintained selections (i.e., PLAY), the change of state remains visible until another function is selected and resets the previous function.
4. The state change of a button or visible object should depict real-world objects as much as possible including the appearance of the button be pressed inward, change in shade of the original color, but not a change in hue.

I. Labels

1. Use of simple words or titles are preferred to indicate functionality, navigation and system status.
2. Use of stylish symbols should be avoided unless their identity is commonly recognized by the general public. Standard symbols for transport functions are acceptable.
3. Labels should be presented in a clear, sans serif type face that will remain legible on lower resolution touch panels.
4. Where physical buttons are present along the side of a touch panel, these buttons should be engraved and filled with a contrasting color.

J. Power On/Off

1. For panels requiring an ON/OFF control, these functions should be linked through current sensors or other methods for the control system to detect the power on condition of the component being controlled.
2. Powering off a system should not interfere with the ability of a projector to complete its cool down cycle.

K. Look & Feel

1. Control pages should utilize a clean, elegant but stylish appearance.
2. Use a common graphical template across all control pages for a consistent look.
3. The touch screen layout should utilize graphical elements such as drop shadows, gradient fills and transparency to provide a pleasing overall appearance.
4. Utilize graphical representations of floor plans to convey location information.
5. Include company logos, icons or watermarks to portray the corporate identity.
6. Provide clear navigation tools for moving between control pages.
7. Each sub-page should have a "BACK" button to return to the previous page. This button should appear in the same location on each page.
8. Provide a "HELP" button or icon on each user page to provide clear, non-technical instructions on how to use the functions available to regular users.

L. Security

1. Provide password access to control pages not intended to be accessed by the general public.
2. Unless otherwise noted, provide a minimum of three levels of access
 - a. General User
 - b. Non-Technical Employee
 - c. AV Technician
3. Segregate the control functions to only allow authorized individuals access to more sophisticated control pages.
4. Provide a timeout feature to automatically return the control panel back to the default opening screen after 30 seconds of inactivity. After this reset, passwords must be reentered to return to a previous control page.

M. Presets

1. For systems that have different operating modes or configurations, provide the ability to store and recall preset combinations of system settings.

2. Provide a "Preset" page that permits a minimum of five presets to be recalled. Each button to include a label describing the function or configuration associated with that button.
3. Provide the ability for new presets to be stored over previous settings. New preset to be able to change the label to reflect the new or revised configuration.
4. When a preset has been recalled, the control page should indicate the active configuration.

3.5 LABELING OF EQUIPMENT

- A. Provide each terminal strip with a unique descriptor and a numerical designator for each terminal. Show terminal strip descriptor and designator on system schematic drawing.
- B. Provide logical and legible cable and wiring label permanently affixed for easy identification.
 1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style.
 2. Wiring designator to be an alpha-numeric code unique for each cable. Actual cable designation assignments to be determined by Contractor. Add cable designation codes to system schematic drawings.
 3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable designator on circuits with intermediate splice points with an additional suffix to indicate each segment.

3.6 ENGRAVING

- A. Text font: 1/8 inch block sans serif characters unless noted otherwise.
- B. On dark materials, provide white characters; on stainless steel or brushed natural aluminum plates, or light-colored materials, provide black characters.
- C. Provide at least two lines of text with first line listing the general device name, e.g., amplifier. Second line to include schematic reference of the device, e.g., AMP-1.
- D. Equipment label: black with white characters except where indicated.

3.7 COMMISSIONING

- A. Prior to energizing or testing the system, ensure the following:
 1. All products are installed in proper and safe manner according to manufacturer's instructions.
 2. Insulation and shrink tubing are present where required.
 3. Dust, debris, solder splatter, etc. is removed.
 4. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
 5. Labeling has been provided.

6. Temporary facilities and utilities have been properly disconnected, removed and disposed of off-site.
 7. Products are neat, clean and unmarred and parts securely attached.
 8. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired, and debris cleaned up and discarded.
- B. Prior to energizing the System verify and perform the following tests and adjustments in compliance with applicable EIA standards.
1. Electronic devices are properly grounded.
 2. Test each AC power receptacle with a circuit checker for proper hot, neutral and ground connections.
 3. Verify each individual component is operating properly.
 4. Verify each individual component's performance meets the manufacturer's published performance for this unit.
 5. Measure and record the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 ohms or less.
- C. Speaker Circuit Verification Test
1. Measure the impedance of each speaker line leaving the equipment racks.
 2. For constant voltage systems measure the impedance at 100 (or 250) Hz, 1 KHz and 8 (or 10) KHz of each line leaving the equipment rack with the line disconnected from the driving source. For band limited devices, use a frequency appropriate for the operating range of the transducer.
 3. When documenting the results of these tests, include the calculated impedance based on number of units on a line and the size and distance of the run. Correct any field readings that differ more than 20% from the calculated impedance.
 4. Include the results of the tests in the Project Record Manual.
- D. Speaker Polarity Verification Test
1. Use an electronic polarity checker, TEF-20, SYSID, SIM II, Smaart, or other similar device to test each loudspeaker. All speakers should have the same relative polarity.
 2. Follow manufacturer's recommendations in conducting the tests.
 3. Include the results of the tests in the Project Record Manual.
- E. Audio Signal Paths
1. Verify operation from each source device through all switching, amplification and distribution devices.
- F. System Gain Adjustment
1. Adjust each active device to have proper gain structure from the mixer output to the input of the amplifier.
 2. With all amplifiers turned off, connect a sine wave or pink noise generator to the input of the mixer. Using an RMS AC voltmeter with a dB scale, adjust the mixer to an output between -10 and 0 dBu. Once the level has been established, it should remain unchanged throughout the test. All equalizers should be set flat for this test.

3. Follow the signal flow from the mixer to each subsequent component. Measure the input level and output level of each device at the point of connection to the device. The input level reading should differ no more than 0.25 dB from the level recorded for the preceding device. Diagnose and correct the wiring or equipment when any readings exceed this range.
4. Adjust the output of each component to achieve the proper output level.
5. Record the output levels of each device in the Project Record Manual.

G. Signal Delay Adjustment

1. Adjust the delay to each subsystem to ensure proper synchronization between the main speakers and delayed speakers.
2. Using a TEF 20, SYSID, Smaart, SIM II, or other acceptable time based measurement system, measure the arrival time of the distant signal and then measure the arrival of the local signal.
3. Based on the arrival times measured, adjust the delay applied to the local speakers to synchronize them with the distant speakers. Repeat the test to verify the delay has been set to within 1 ms of the arrival of the distant signal. Once the precise delay time has been determined, provide an additional 10 ms of Haas effect delay to maintain directional orientation toward the original sound source.
4. Continue to test and adjust each separate subsystem with a dedicated delay channel.
5. Provide hard-copy printout of each delay adjustment showing first the arrival times with no delay set and then the result after the delay has been adjusted. Record the settings of each delay in the Project Record Manual.

H. Remote Input Verification Test

1. Using a microphone or portable signal generator, connect to each microphone/line level receptacle throughout the facility.
2. Verify that the receptacle under test appears at the correct input and is operating properly.
3. In a similar manner, check all remote tielines and media related lines for correct wiring and labeling.

I. System Equalization

1. Using a RTA, TEF 20, SYSID, or SMAART, equalize all loudspeaker systems to provide a suitable frequency response as follows:
 - a. Speech Reinforcement Systems: flat response from 125 Hz to 2.5 KHz, with 2 dB roll off above.
 - b. Program Reproduction Systems: flat response from 65 Hz to 8 KHz, with 2 dB roll off above.
2. Verify system gain and amplifier levels.
3. Provide program levels of at least 85 dB and speech reinforcement levels of at least 70 dB in the seating area without objectionable distortion, buzzes, or rattles.
4. Provide hard copy printouts of the spectral response with the test data.

J. RFI and Parasitic Oscillation

1. With systems operating check to ensure that all systems are free from spurious oscillation and radio frequency interference in the absence of audio signal.

K. Buzzes, Rattles and other Distortions

1. Adjust the system for normal operating level in the space. Apply a slow sine wave sweep from 60 Hz to 3 KHz and listen carefully for buzzes, rattles and other objectionable distortions.
2. Correct the cause of the defect. If the cause is not from the system. Bring the cause to the attention of the GC, indicating cause and suggestive corrective actions.

L. Video Systems Test

1. Projected images and screen must be plumb with respect to ceiling line.

M. Video System Tests. Verify performance of all video equipment, components and systems, as specified herein.

1. Video (signal):
 - a. S/N (peak to RMS), unweighted DC to 4.2 MHz: 55 dB minimum.
 - b. Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum.
 - c. Frequency Response: Within plus to minus 0.5 dB to 4.2 MHz.
 - d. Line and Field Tilt: 2% maximum.
 - e. Differential Gain: 2% maximum.
 - f. Differential Phase: 2 degrees maximum.
 - g. Frequency Response: DC to 4.2 MHz within plus or minus 0.5 dB.

N. Video Signal Paths

1. Verify operation from each source device through all switching, amplification and distribution devices.

O. Video Test Report shall include the following:

1. Test Failures and Notices
 - a. Sink Device EDID Test – Open items or failures shall not be accepted.
 - b. Cable Length Test – Open items or failures shall not be accepted.
 - c. HDCP KSV Limitations – Limitations shall not be accepted.
 - d. Cable Limitations - Limitations shall not be accepted.
 - e. EDID Limitations - Limitations shall not be accepted.
 - f. Cable Length Limits exceeded – Failing cables shall not be accepted.
2. Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
3. Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
4. EDID – Input Resolution and 3D support status for each input.
5. EDID – Supported Output Resolution and 3D support status for devices connected to each output.
6. EDID – Supported Audio formats for each input.
7. EDID – Supported Audio formats for devices connected to each output.

P. Control Systems

1. Verify operational functions of the control system and all interfaced devices.
2. Verify operational functionality of any wireless user devices.

3.8 CAT5E/CAT6 CABLE CERTIFICATION

A. General Field Test Requirements

1. All CAT5E/CAT6 cabling links installed as part of this scope shall be tested for the following, in accordance with the field test specifications defines in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard.” This document will be referred to as the “Category 5e Standard”:
 - a. Wire Map
 - b. Length
 - c. Insertion Loss
 - d. NEXT loss
 - e. PS NEXT Loss
 - f. ACR-F Loss
 - g. PS ACR-F Loss
 - h. Return Loss
 - i. Propagation Loss
 - j. Delay Skew
2. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the “Permanent Link” performance specification as defined in the Category 5e Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 5e standard mentioned above and as further detailed in Section B below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. The test equipment (tester) shall comply with the accuracy requirements for level IIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the channel configuration).
5. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
7. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
8. The Pass or Fail condition of the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass.
9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specifies test limits for that parameter.

B. Performance Test Parameters

1. The test parameters are defined by the Category 5e Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 100 MHz) must meet or exceed the limit value determined in the above mentioned standard.
2. Wire Map - Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct.
3. Length – The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
4. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 100 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk Ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results of the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which the worst case value occurs, and the test limit value at this frequency.
5. NEXT Loss – Pair-to-pair near end crosstalk loss (abbreviated as NEXT loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 100 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT loss measurements shall not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

Table 1 – Maximum frequency step size as defined in ANSI/TIA-1152

Frequency Range (MHz)	Maximum Step size (MHz)
1 - 31.25	0.15
31.26 - 100	0.25

6. PS NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 100 MHz and the step size may not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Maximum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS next. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

7. ACR-F Loss, pair to pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured 1 through 100 MHz and the maximum step size for FEXT loss measurements shall not exceed the maximum step size defined as the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value for ACR-F. There wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
8. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs of the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
9. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst value of Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
10. Propagation Delay – Propagation delay is the time required for the signal to travel from one of the links to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
11. Delay Skew – [as defined in the Category 5e Standard; Section 6.2.19] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

C. Test Result Documentation

1. The test results/measurements shall be transferred into a Windows based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.

2. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
 - a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
 - c. The date and time the test results were saved in the memory of the tester.
4. General information to be provided in the electronic data base with the test results information for each link:
 - a. The identification of the customer site as specified by the end-user.
 - b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - c. The overall Pass/Fail evaluation of the link-under-test
 - d. The name of the test limit selected to execute the stored test results
 - e. The cable type and value of NVP used for length calculations
 - f. The date and time the test results were saved in the memory of the tester
 - g. The brand name, model, and serial number of the tester.
 - h. The identification of the tester interface
 - i. The revision of the tester software and the revision of the test limits database in the tester
 - j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.
5. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
6. The detailed test results data to be provided in the electronic database must contain the following information:
 - a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m330 and test limit value.
 - b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
 - c. Delay Skew: Identify the pair with the largest value for delay skew, the value measured in nanoseconds (ns) and the test limit value.
 - d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair.
 - e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link.
 - f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.
 - g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.

3.9 FINAL OBSERVATION & TESTING

- A. Upon completion of installation, initial adjustments, tests and measurements specified in Part 3, and submission and review of the results, a final observation and test will be performed by the Owner or Owner's representative no earlier than two weeks after receipt of the written results.
- B. Provide a minimum of one (1) person for observation and testing familiar with aspects of the System to assist the Owner.
- C. The process of testing the System may necessitate moving and adjusting certain components.
- D. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.
- E. The following procedures will be performed on each System:
 - 1. Observation of the methods and means employed to incorporate the System within the facility.
 - 2. Verification of proper operation, from controlling devices to controlled devices.
 - 3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each level control, and appropriately record these settings within the Record Documents.
 - 4. Other tests on equipment or systems deemed appropriate.
- F. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the observation and testing period is required, the Contractor shall pay for additional time and expenses of the Owner at the standard rate in effect at that time.

3.10 TEST EQUIPMENT

- A. Thirty days prior to start of testing, provide a list to the Owner of test equipment make, model numbers and calibration dates that will be used.
- B. The following equipment shall be available on site for the entire test period through final system testing.
 - 1. Sound Level Meter : ANSI S1.4-1971 Type S1A with digital or analog display. Meter to provide ranges of 40 to 120 dBA.
 - 2. Pink Noise Source - Equal energy per octave bandwidth 20 Hz to 20,000 Hz, ± 1 dB (long-term average) at 0 dBm output. Stability: ± 2 dB per day.
 - 3. Dual-trace oscilloscope - 100 MHz bandwidth, 1 mV/cm sensitivity.
 - 4. Impedance Meter - Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 5k Hz. Measurement Range: 1 ohm to 100 kohms.

5. Audio Oscillator: bandwidth 20 Hz to 20k Hz \pm .5 dB at 0 dBm output. Output to be balanced. Oscillator to include adjustable output level over the range from -30 dBu to +10 dBu.
 6. Multimeter - Measurement range, DC to 20k Hz, 100 mV to 300 V, 10 ma to 10 A, dB.
 7. NTSC Test generator
 8. Real time analyzer with LED or CRT display. The unit shall meet the filter requirements of ANSI S1.11 Class III for one third octave filters.
 9. Video (analog) test generator capable of generating signal up to 1920 x 1200 with audio.
 10. Video (digital) test generator capable of generating signal up to 1920 x 1200 with audio.
 11. Ladders and scaffolding necessary to inspect elevated equipment, junction boxes, etc.
- C. Provide three portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover entire project. Include rechargeable batteries and recharger along with holster for wearing on belt. Radios to be available for duration of testing process, including any follow-up visits required prior to final acceptance.

3.11 INSTRUCTION OF OWNER PERSONNEL

- A. Provide instruction to Owner designated personnel focusing on the use, operation and maintenance of the systems, scheduled as a minimum of two separate sessions, by an instructor fully knowledgeable and qualified in system operation. The System Reference Manuals should be complete and on site at the time of this instruction. Coordinate schedule of demonstration with Owner's Representative.
1. AV System
 - a. 4 hours of instruction
- B. Video record all training sessions and compile a training video to be provided to the Owner on DVD.
- C. Provide sign in sheet to document the attendee's presence.
- D. If Contractor is not properly equipped to conduct Owner training on particular equipment, arrange for factory representatives of the equipment to be present to provide training at no additional cost to the Owner.

3.12 CLEANUP AND REPAIR

- A. Upon completion of the work, remove refuse and rubbish from and about the premises. Leave areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.

END OF SECTION 27 41 16

SECTION 27 41 16.1 – BOWL SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including all General and Supplementary Conditions and Division 1 Specification sections shall apply to this section and shall be considered as forming an integral part of this Work. These documents are referred to as the Project General Conditions in the remainder of these Specifications.
- B. The Common Work Results shall apply to Work specified in this Section.
- C. The following sections are related and have interaction between them.
 - 1. Division 26 Electrical
 - 2. Division 27 Structured Cabling and Pathways

1.2 REFERENCES

- A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
 - 1. American National Safety Institute (ANSI)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. Electronics Industries Association (EIA)
 - 4. Federal Communications Commission (FCC)
 - 5. National Electrical Manufacturer's Association (NEMA)
 - 6. National Electrical Code (NEC)
 - 7. Underwriters Laboratories (UL)
 - 8. Occupational Safety and Health Administration (OSHA)
 - 9. Society of Motion Picture and Television Engineers (SMPTE)
 - 10. Building Industry Consulting Service International (BICSI)
 - 11. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
 - 12. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
 - 13. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009

1.3 SUMMARY OF WORK

- A. Work specified in this Section includes a variety of component and cabling re-location, removal and re-installation for the existing 1st base line field lighting standard speaker cluster.
- B. The stadium's sound system was installed by Precision Audio. It is recommended that they are contacted to perform this work. Scott Carneval 919-820-9910.
- C. Contractor will provide personnel and field equipment necessary to:

1. Remove and store the existing speaker assembly.
2. Remove low voltage speaker cabling.
3. Re-install new low voltage speaker cabling to the new lighting standard location as noted on the architectural drawings.
4. Re-install speaker assembly or provide new components on new lighting pole location.
5. Aim, calibrate, tune, test for optimal performance to areas of coverage.



6.

1.4 PROJECT CONDITIONS

- A. Verify all conditions on the job site applicable to this work. Notify Owner/Owner's Representative in writing of discrepancies, conflicts, or omissions within three (3) days of discovery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All cabling, connectors, termination panels and distribution methods shall be new and for use in the existing bowl sound system.

PART 3 - EXECUTION

3.1 GENERAL

- A. Take care to prevent scratches, dents, chips, etc.
- B. Mount equipment and enclosures plumb and square. Permanently placed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least three. Seismic bracing shall be placed on appropriate equipment where local codes require such installation.
- C. Cover edges of cable pass-through holes in chassis, racks, boxes, etc., with rubber grommets or Brady GRNY nylon grommets.
- D. Adhere to all local and national electrical codes and standards.
- E. Cable Labeling
 - 1. Cables and wiring to be logical, legible, and permanently labeled for easy identification. Labels on cables to match existing conditions.

3.2 TESTS AND ADJUSTMENTS

- A. Verify the following before beginning actual tests and adjustments on the system:
 - 1. Electronic devices are properly grounded.
 - 2. Powered devices have AC power from the proper circuit and hot, neutral, and ground conductors are connected correctly.
 - 3. Insulation and shrink tubing are present where required.
 - 4. Dust, debris, solder splatter, etc. are removed.
 - 5. Cable is dressed, routed, and labeled; connections are consistent regarding polarity.

3.3 INSTALLATION

- A. Installation shall include all required and operationally necessary low voltage speaker cabling for the new speaker location.
- B. Cable shall carry appropriate fire rating (e.g. CMR, CMP, OFNR, OFNP, etc.) on jacket of cable.
- C. Do not damage any signal cabling that may be co-located with this new cabling. In the event of damage, bring damage to the attention of the owner and propose acceptable repairs.

3.4 TESTING AND COMMISSIONING

- A. The Contractor shall be responsible for testing and commissioning the installation in accordance with all system and manufacturer recommendations.
- B. Testing shall be comprehensive and sufficient to demonstrate compliance with each requirement.
- C. Final tests shall be conducted in the presence of the Contracting Officer or Owner.

END OF SECTION 27 41 16.1

SECTION 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. See individual related documents for summary of work for each section.
- B. Work will consist of providing and installing prescribed systems and equipment, in accordance with the Owner's directives and needs. Contractor will design, install, and configure systems to provide the exact function described herein, when specified, and will be held to the operational criteria. Contractor will be responsible for providing and installing a complete and fully operational system, with the intended features and capabilities, whether or not all required parts, components, systems or accessories are specified in the construction documents. Contractor will provide all required parts, components, systems, materials, accessories, and programming needed for a complete and working system, without additional cost to Owner.
- C. Although such work is not specifically indicated, provide, and install supplementary or miscellaneous items, appurtenances, and devices incidental to, or necessary for, a sound, secure and complete installation.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including all General and Supplementary Conditions and Division 1 Specification sections, will apply to this section and will be considered as forming an integral part of this Work. These documents are referred to as the Project General Conditions in the remainder of these Specifications. Where the Project General Conditions conflict with the requirements defined herein, the more stringent of the requirements and the Project General Conditions will prevail.
- B. This Specification Section incorporates general requirements for the following security sections.
 - 1. 28 05 13 Conductors and Cables for Electronic Security

1.3 RELATED WORK NOT IN THIS SECTION

- A. General and specific provisions of these Specifications apply to the work specified in this Section, as well as:
 - 1. Mockups
 - 2. Division 07 Firestopping
 - 3. Division 08 Door Hardware
 - 4. Division 26 Electrical
 - 5. Division 27 Structured Cabling System

1.4 DEFINITIONS

- A. Owner's Representative: The representative or representatives appointed by the Owner responsible for project construction supervision.
- B. Provide: To purchase, deliver to site and furnish all labor and material as necessary for a complete and operational system as specified herein.
- C. Contractor: The Party contracted by the Owner or their designated representative to Provide Work specified herein.
- D. Contract Documents: Documents used to specify the Work and govern the work of Contractor in their entirety or in part.
- E. Work: The entire completed construction of the individual parts of the project as specified herein.
- F. Local Authority Having Jurisdiction: The local governmental entity responsible for adopting and enforcing all code requirements at the location Work is being performed.
- G. Project General Conditions: Include all relevant contractual requirements for the Project to include Division 1 General Conditions as well as Owner-provided and established contractual provisions.
- H. Security Subsystem Specifications: Those specifications that apply to security subsystems for which these General Security Requirements apply.
- I. The following are definitions utilized within this specification section:
 - 1. (ACS) Access Control System
 - 2. (VMS) Video Management System
 - 3. (GUI) Graphical User Interface
 - 4. (IP) Internet Protocol
 - 5. (KVM) Keyboard Video Mouse
 - 6. (UI) User Interface

1.5 SOFTWARE AND NETWORK

- A. Custom Software Overview:
 - 1. Integration of the Division 28 sections, including programming and development of any custom software that may be required of this section, is the responsibility of the Contractor(s). It is the responsibility of the Contractor(s) to work with the Owner and manufacturer(s) to develop these integrations. When custom modules are required, it will be the responsibility of the Contractor(s) to coordinate with manufacturer(s) for APIs and SDKs in order to have the programs written.
 - a. Custom software programming must be contracted to the manufacturer to write; however, the expense of the development will be the responsibility of this section.
 - b. Any custom software developed for this project shall be maintained for changes to all systems integrated for a minimum of five years after completion of the project.

1.6 REFERENCES

- A. American National Standards Institute (ANSI)
- B. Electronic Industry Association (EIA)
- C. National Electric Code (NEC)
- D. Telecommunications Industry Association (TIA)
- E. National Electrical Manufacturer's Association (NEMA)
- F. Underwriters Laboratories (UL)
- G. National Fire Protection Association (NFPA)
- H. Federal Communications Commission (FCC)
- I. Institute of Electrical and Electronics Engineers (IEEE)
- J. Occupational and Safety Health Administration (OSHA)
- K. Open Network Video Interface (ONVIF)

1.7 APPLICABLE CODES AND STANDARDS

- A. The Contractor will ensure that all Work provided under this section will meet the minimum requirements of all applicable codes and standards, as determined by the LAHJ.
- B. Where the requirements of this section exceed the minimum requirements of the LAHJ, this section will govern. Where codes conflict with the Contract Documents, codes will govern. Where any applicable codes and standards conflict between themselves, the more stringent will apply.
- C. Nothing in this section will relieve Contractor from the responsibility for compliance with all applicable codes, standards, or specifications which are generally recognized to be applicable to the Work specified herein.
- D. Contractor will make application for, and obtain, any and all permits required by federal, state, county, city or other LAHJ over the work. In the event inspections are required, it will be the responsibility of Contractor to schedule and ensure the completion of said inspections and to ensure that all necessary certificates are issued, obtained, and delivered to the Owner.
- E. Within this Section and the Security Subsystem Specifications, reference is made to United States-based standards, codes, and legislation. For projects outside the United States, the corresponding local codes, standards, and legislation will apply, except where local requirements are less stringent than those proscribed within the referenced United States requirements. In these cases, the referenced United States requirements will apply.

1.8 SUBMITTALS

- A. General:

1. Coordination is required with the Contractor for complete shop drawings and submittal packages.
2. Provide simultaneously the following for approval thirty (30) days after issuance of notice to proceed and prior to commencement of work:
 - a. Complete schedule of submittals.
 - b. Chronological schedule of work in bar chart form.
3. Submittal format:
 - a. Provide a unique control number in consecutive order.
 - b. Provide a complete table of contents with the following information:
 - 1) Project title and number.
 - 2) Submittal number.
 - a) In the case of a re-submittal, use the original submittal number immediately followed by the suffix "R" immediately followed by a unique number and be numbered in consecutive order.
 - c. Date of submission.
 - d. Referenced addendum or change order number as applicable.
 - e. Referenced specification Section, Part, Article, Paragraph, and page number or drawing reference as applicable:
 - 1) Index by the data in specification order, manufacturer, and model or part number unless specified otherwise herein.
 - f. Each submission page stamped with Contractor's certification stamp, initialed, or signed certifying:
 - 1) Review, approval, and acceptance of submission.
 - 2) Certification of product compliance to specification.
 - 3) Verification products may be incorporated within the work.
 - g. Arrange product data list in specification order when applicable followed by unspecified product arrange by manufacturer and model or part number. Follow list by manufacturer's data sheets, arranged in the same order. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.
 - h. Drawings executed at an appropriate scale, but not smaller than 1/8" = 1'-0". Provide one (1) reproducible and two (2) bound prints of which the processed reproducible will be returned to Contractor, additional prints will not be reviewed or returned.
 - i. Submittal documents shall be computer generated. Free-hand sketches or reproductions of Contract Documents will not be acceptable, and Contractor will be deemed nonresponsive.

B. Samples as required within these specifications:

1. Provide cable samples of all cables specified in this division:
 - a. Each cable sample will have the rating as required by the NEC printed on the jacket by the manufacturer:
 - 1) Identify each sample with the specification section it is being submitted for.
2. Provide a letter from the manufacturer with estimated lead time for each type of cable.

C. Prefabrication as required within these specifications:

1. Prefabrication submittals will be submitted in English in addition to the local language. Submittals not translated to English will be rejected without review.

2. Prefabrication submittals will completely demonstrate the Contractor's understanding and interpretation of the systems, equipment, devices, and components being installed. Prefabrication submittals will consist of shop drawings and product data as defined herein. Submittals will clearly show materials, dimensions, operational features, durability, technical limitations and requirements, and all other information required for a complete and thorough review.
3. Acceptance of prefabrication submittals by the Owner's Representative will not relieve Contractor from any responsibility to Provide Work as defined in the Contract Documents. No portion of the Work will commence until the Owner's Representative has approved the prefabrication submittals in writing.
4. All prefabrication submittals will be submitted by Contractor in their complete form. Partial submittals will not be considered.

D. Action Submittal:

1. This submittal is intended to be used when a substitution is being requested.
2. Product Data:
 - a. Provide a list of, and manufacturer's data sheets on, product(s) to be incorporated within the work:
 - 1) Manufacturer's product technical datasheet for each product in sufficient detail to facilitate proper evaluation to the product's suitability for incorporation within the work. Where multiple products are shown on the same datasheet, the product intended to be used shall be identified in a manner that can be photocopied in black and white.
 - 2) Manufacturer's wiring diagram for electrically actuated units in sufficient detail to facilitate proper evaluation to the products suitability for incorporation within the work.
 - 3) Organize the data sheets in the order of the specification.
3. Comparison Matrix:
 - a. Provide a Matrix showing the features of the specified product in one column with the next column depicting how the proposed item's features compared.
 - b. Highlight any item that does not exceed the specification or feature of the specified device.
 - c. Provide documentation showing the device being substituted is on the approved devices list:
 - 1) If generic ONVIF driver is used the Contractor will show that the substituted product will have the same quality and features as the native driver for the originally specified product.
4. Shop Drawings:
 - a. See below.
5. Samples, if required by Owner or Architect.

E. Informative Submittal:

1. This submittal is intended to be used when using specified equipment.
2. Product Data:
 - a. Provide a list of, and the manufacturer's data sheets on, product to be incorporated within the work:
 - 1) Manufacturer's product technical datasheet for each product in sufficient detail to facilitate proper evaluation to the products suitability for

incorporation within the work. Where multiple products are shown on the same datasheet the product intended to be used shall be identified in a manner that can be photocopied in black and white.

- 2) Manufacturer's wiring diagram for electrically actuated units in sufficient detail to facilitate proper evaluation to the products suitability for incorporation within the work.
 - 3) Organize the data sheets in the order of the specification.
3. Shop Drawings:
 - a. See below.
 4. Samples if required by owner or architect.

F. Shop Drawings:

1. Shop Drawings will be computer generated in AutoCAD® Revit. Coordinate version with Owner's Representative. Drawings will be precisely scaled. Free-hand sketches or reproductions of Contract Documents will not be acceptable, and Contractor will be deemed nonresponsive.
2. PDF prints will be produced of all sheets and organized following the architectural numbering format.
3. Coordinate with the Owner's Representative to obtain architectural model/backgrounds in electronic or hardcopy format for use in the Shop Drawings.
4. Shop Drawings will consist, at a minimum, of the following:
 - a. Floor plan drawings indicating the location of all security devices as well as all wire runs and designations.
 - b. Plans, elevations, and details indicating dimensions, gauges, reinforcement, anchorage, and other installation details for each device as required.
 - c. System point-to-point diagram indicating the inter-relationship of all security system peripheral devices, control panels, software/monitoring workstations, and other components as necessary for a complete and operational system.
 - d. Typical wiring diagrams for each system peripheral device.
 - e. Specific wiring diagrams for each system control panel, power supply, video recorder or other device or equipment that controls or communicates with multiple peripheral devices.
 - f. Fabrication shop drawings for all custom equipment.
 - g. Installation: Special details depicting methods and means specific to each product, assembly and each product manufacturer's recommended installation methods and means.
 - h. Equipment: Location of equipment, with dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations. This will include equipment closet layouts, power inserters, camera power supplies etc.
 - i. Camera mounting details for each camera position. Each mounting detail will contain sufficient scaled detail to indicate the entire coverage area and attachments.
 - j. Control software screens. Provide color printouts of screen layout for camera, floor layouts, and controls. This requirement is to be coordinated with the GUI development process.
 - k. Fabricated plates and panels: Provide complete drawings on custom fabricated plates or panels. Drawings to include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material.

- l. Labeling: Representative equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and descriptor and designator schedule.
- m. Any other pertinent data generated which is necessary to provide the Work.
- n. Seek the services of a state licensed structural engineer to stamp and approve mounting details of cameras mounted on any location requiring a foundation, dedicated poles (such as outside locations), or where the objects are mounted over seating areas.
- o. Copying contract documents and returning them as shop drawings will be considered as nonresponsive.

G. Record Documents:

- 1. Submit four (4) bound originals of the following Project Record Manual information after substantial completion and prior to final inspection:
 - a. Product Data: Product actually incorporated within the Work:
 - 1) Manufacturer's data for each type of product conforming to the scheme specified herein.
 - 2) Include manufacturer's serial numbers within the list of products.
 - 3) All product data for the Project will be tabulated into a comprehensive list of equipment to be provided for the Project, including quantities, manufacturer names, model numbers, description, and any applicable options. The product data submittal will be of sufficient detail that the Owner's Representative may readily identify the equipment and materials proposed.
 - b. Provide all product data in hard copy organized in three (3) ring binders as well as three (3) in electronic formats on CD or USB thumb drive. Bind Project Record Manual in titled three ring D-style binders sized for 150-percent of the material in general conditions sections described previously as part of this specification. Maximum size: three-inch ring. Use multiple volumes if necessary:
 - 1) Product data will consist, at a minimum, of the following:
 - a) Product data sheets for each piece of equipment included in the project identifying the following:
 - (1) Materials and Fabrication.
 - (2) Tolerance
 - (3) Power and environmental / HVAC requirements.
 - (4) Special criteria related to particular systems and components.
 - (5) Specifically, and clearly, mark items submitted where multiple items and options occur on a sheet.
 - c. Identify all Parts and Components by name and manufacturer's number:
 - 1) Manufacturers' brochures for each of the system components included. Contractor will submit original brochures; copies will not be acceptable. Where information is in color, all copies will be provided in color.
 - 2) Schedules will independently identify each piece of equipment, component, and device provided for the project; including project name/number reference, product name and number, installation location, and conductor/cable identifications that devices are connected to.
 - d. Reference both manufacturer and construction document identification.
 - e. For information submitted in a schedule, include information independently in an organized and consistent format.
 - f. Provide programming point information within the schedules:

- 1) At the request of the Owner's Representative and as identified in Security Subsystem Specifications, submit color samples for specific pieces of equipment.
- 2) Where test data is required by the Security Subsystem Specifications or Project General Conditions, all tests must be specific to products supplied specific for this project.
- 3) Certificates and Testing Information:
 - a) Provide a manufacturer's certificate certifying that Products meet or exceed specified requirements.
 - b) Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency.
- 4) The Owner's Representative will have the right to request additional information as required for a proper review of the submittal information.
- 5) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item.
- 6) Manufacturer's wiring diagram for each type of product actually incorporated.
- 7) Manufacturer's maintenance and care instructions.
- g. Record Drawings: Final rendition of submission depicting what is actually incorporated within the Work.
- h. Test Reports: Recorded findings of Contractor's Commissioning.
- i. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
 - 1) This procedure should describe the operation of system capabilities.
 - 2) Assume the intended reader of the manual to be technically inexperienced and unfamiliar with this facility.
- j. Maintenance Instructions: Maintenance phone number(s) and hours, maintenance schedule, description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
- k. Any other pertinent data generated during the Project or required for future service.
- l. Segregate documents within the three separate bindings containing data relevant to operational, maintenance and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g., operational data in maintenance binding.
- m. Provide the same layout in PDF form within the electronic storage media listed above. The bindings would be electronic folders. All PDF files must be flattened so that any notes or comments are not able to be moved accidentally when selected.

1.9 CLOSEOUT SUBMITTAL

- A. Copy of Maintenance contracts.
- B. Operation and Maintenance Manual and Schedule.
- C. Bonds.
- D. Warranty Documentation.
- E. Record Documentation.

F. Copy of software.

1.10 MAINTENANCE MATERIAL SUBMITTAL

A. Copy of Maintenance contracts.

B. Operation and Maintenance Manual and Schedule.

1.11 RESUBMITTAL

A. Resubmission Requirements:

1. Make any requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.

a. Indicate any changes that have been made other than those requested. Identify each change or correction with the appropriate delta identifier and cloud the change.

B. Replace, at no expense to Owner, product damaged during storage, handling, or the course of construction.

1.12 SITE DOCUMENTATION

A. Contractor will maintain up-to-date record drawings on site for inspection by the Owner's Representative. Each change to the original approved submittal data and deviation from the Contract Documents will be indicated on the record drawings. Contractor will ensure that the record drawings are protected against soiling, tears, or other damage or defacement. At the conclusion of the Project the Contractor will incorporate all changes on the record drawings into electronic format and will submit the completed set as As-Built documentation as defined in the section titled "Record Documentation" herein.

1.13 QUALITY ASSURANCE

A. Contractor will have a minimum of five (5) years of experience in the design, installation, and commissioning of projects of a similar nature. Contractor will provide evidence of completion of at least two (2) projects of a similar size which have been in operation a minimum of one (1) year.

B. The Contractor will be equipped to support the Project from a local field office. The office will offer twenty-four (24) hour emergency service with a maximum response time of four (4) hours. The Contractor will have an in-depth understanding of all local codes and requirements for the area that the Project is located in.

C. Contractor will be an authorized dealer of each of the major access control, intrusion detection, and video product lines specified in the associated specification sections. Contractor will provide written proof of dealership status along with bid.

D. In addition to experience requirements stated, Owner's Representative reserves the right to require:

1. Site visit to at least two (2) facilities where installations have occurred and are in use.
2. Owner approval.
3. Surety bond backed warranty.
4. Proof that Contractor or bidder is familiar with installations to be made.
5. Background information on prior installations, including the following information:
 - a. Owner, Architect, and Contractor contacts
 - b. Names
 - c. Phone numbers
 - d. Addresses

1.14 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with manufacturer's recommendations, so as to minimize the opportunity for damage, deterioration, or loss.
- B. The Owner assumes no liability or responsibility for loss by theft, vandalism, or burglary of material or equipment stored on site.
- C. Deliver all equipment and material to the site in the manufacturer's original sealed packaging. Packaging is to provide factory identification of items contained within the packaging and protection until the items or materials are installed. Inspect all equipment and material upon delivery to ensure that they are free from damage and in accordance with the Contract Documents.
- D. Store products in their original packaging until installation. Protect from spoilage, moisture, all weather-related conditions, corrosion, breakage, or other damaging elements. Store in conditions that will ensure all required manufacturer's environmental criteria are maintained until use of material or products.
- E. Acceptance of the products constitutes the Contractor's acknowledgment that products or materials are satisfactory for use.

1.15 TECHNICAL SYSTEMS SOFTWARE LICENSE

- A. Introduction:
 1. All proprietary software provided for the Technical Systems will be subject to this software license agreement between the Contractor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings, and agreement.
 2. Contractor will agree that 3rd party (e.g., manufacturer's) proprietary software provided with the system will be subject to this agreement.
 3. Contractor and Owner agree this software license is deemed to be part of, and subject to, the terms of the Agreement applicable to both parties; and will supersede any standard manufacturer or Contractor's standard license agreement.
 4. Proprietary software will be defined to include, but not be limited to, device and system specific software and firmware designed to run on conventional computer based operating platforms as well as all micro-processor-based hardware used to program, setup, or operate the system or its components.

5. For sake of this agreement, MS Windows® will not be considered “proprietary” software, unless a non-public version of Windows® or any of its components are critical to the operation of the system in which case it will be deemed proprietary.

B. License Grant and Ownership:

1. Contractor hereby grants to Owner a perpetual, non-exclusive, site license to all software for Customer’s use in connection with the establishment, use, maintenance, and modification of the system implemented by Contractor. Software will mean executable object code of software programs and the patches, scripts, modifications, enhancements, designs, concepts, or other materials that constitute the software programs necessary for the proper function and operation of the system as delivered by the Contractor and accepted by the Owner.
2. Except as expressly set forth in this paragraph, the Contractor, at all times, will own all intellectual property rights in the software. Any, and all, licenses, product warranties, or service contracts provided by third parties in connection with any software, hardware, or other software or services provided in the system will be delivered to Owner for the sole benefit of Owner.
3. Owner may supply to Contractor or allow the Contractor to use certain proprietary information, including service marks, logos, graphics, software, documents, and business information and plans that have been authored or pre-owned by Contractor. All such intellectual property will remain the exclusive property of Owner and will not be used by Contractor for any purposes other than those associated with delivery of the system.
4. Contractor shall provide all licenses or modules to make the system fully functional.

C. Copies, Modification, and Use

1. Source code will be available to Owner for a period of not less than ten (10) years.
2. Owner may make copies of the software for archival purposes and as required for modifications to the system. All copies and distribution of the software will remain within the direct control of Owner and its representatives.
3. Owner may make modifications to the source code version of the software, if, and only if, the results of all such modifications are applied solely to the system. In no way does this Software License confer any right in Owner to license, sublicense, sell, or otherwise authorize the use of the software, whether in executable form, source code or otherwise, by any third parties.
4. All express or implied warranties relating to the software will be deemed null and void in case of any modification to the software made by any party other than Contractor.
5. During the life of the system (defined as a period of not less than ten (10) years and not more than fifteen (15) years), the Contractor will provide software updates in accordance with all necessary support requirements to maintain the system. This will include a commitment to provide appropriate patches, fixes, and interface updates as necessary to maintain the operability and security of the system at a level commensurate with the original system:
 - a. In the event computer and/or processor hardware refinements and updates are necessary to support software updates five (5) years after substantial completion, said hardware will be provided to Owner at negotiated terms between the Contractor and the Owner.

- b. Labor will be in accordance with change order rates of the original contract, as adjusted for inflation in accordance with conditions and limitations of the general Contractor or U.S. Bureau of Labor Statistics' Consumer Price Index (CPI).
- 6. All hardware supplied will support software updates for a period of not less than five (5) years following substantial completion.

PART 2 - PRODUCTS

2.1 MATERIALS, EQUIPMENT, AND DEVICES

- A. Herein, and within the related Sections of Work identified herein, performance requirements and other specifications related to equipment to be provided as part of this Project are listed. Contractor will refer to the identified product or a known equal for acceptable manufacturers of equipment.
- B. "Or approved equal" basis:
 - 1. The products are listed, or are on, an approved equal basis. The known equals to the products specified are listed in each section.
 - 2. Substitute products not listed in this section may be submitted for approval during the question-and-answer period of the bidding phase. See substitution requirements in this section.
 - 3. Substitution approvals will be based on the complete functionality, integration, operation, and user interface as it compares to the specified product(s).
 - 4. Products not approved prior to the bidding phase will be deemed non-responsive.
- C. Provide products of types, materials, sizes, capacities, and electrical characteristics as indicated. Products will meet the following requirements:
 - 1. Design and construction will be as recommended by manufacturer and as required for installation.
 - 2. Provide manufacture's standard product as indicated by published product information.
- D. Where special power treatment is required, such as filtering or spike elimination that may be required for proper operation of the system, Contractor will provide as part of the system.
- E. Acceptable product will be as indicated in each section. All products will meet the following requirements:
 - 1. Manufacturer will have a minimum of five (5) years' experience producing the specific types of products to be used.
 - 2. All like equipment, components, and devices will be by one (1) manufacturer where possible unless the major component manufacturer does not provide a specific device, (example; 180° or 360° camera).
 - 3. Where different manufacturers must be provided, all products will be totally compatible.
- F. Where specific model numbers are not provided for a specific manufacturer, information is provided to indicate the level of quality to be met by other approved manufacturers:

1. Systems provided are to be of factory designed, independently tested, published components; coordinated, designed, and interfaced to perform as one unitized system.
2. Include all required wire, cable, fittings, and miscellaneous accessories.
3. Unless specifically noted, components and system logic will be provided through microprocessors and pre-designed cards.
4. Provide low voltage components and devices where possible.
5. Provide only systems designed for continuous 24-hour, 7 days a week operation.

2.2 FABRICATION

A. Electronic Equipment and Components:

1. To the greatest extent possible, provide standard equipment and components, designed to operate as complete coordinated systems capable of interfacing with all related systems required for the work.
2. Where custom fabricated and integrated systems or components, such as vehicular pedestals, are required or indicated, provide compatible components and complete system to attain performance and operational capabilities intended.

B. Factory finish all components:

1. Where selected color is not specifically identified in contract documents, submit sample materials finished with actual colors and textures. Contractor will submit for approval the full range of colors and textures for approval by the Owner's Representative.
2. See Security Subsystem Sections for specific finishes.

C. Provide factory-fabricated wire of the size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with local standards adopted by the LAHJ.

PART 3 - EXECUTION

3.1 EXAMINATION AND SITE PREPARATION

- A. Prior to bidding, examine the project (if under construction) for nature, scope, and intent of all work to be performed and notify Owner's Representative in writing of any conditions determined to be detrimental to proper completion of the Work.
- B. Submission of a bid/proposal will constitute that examination has been made, and any difficulties foreseen identified and noted. Any claims for labor, work, materials, or equipment for difficulties encountered which should have been foreseen, will not be recognized; and will be taken care of by the Contractor at no additional cost to the Owner.
- C. Do not proceed with Work until all unsatisfactory conditions have been corrected.
- D. Prior to installation of systems components and devices, verify all required preparations have properly occurred and those substrates are acceptable for installation:
 1. Verify all rough-ins and field dimensions.

2. Report any discrepancies, unsatisfactory conditions and prevailing conditions that will adversely affect satisfactory execution of work for systems included under this specification section.
 - a. Do not proceed with work until unsatisfactory conditions have been corrected.
 - b. Owner's Representative reserves the right to review proposed methods of direction, reject proposed methods and have the installation done in a satisfactory method at the Contractor's cost.
 - c. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Install all system components in accordance with manufacturer's written instructions, in compliance with all applicable codes and standards, and in accordance with recognized industry practices.
- B. Ensure that all equipment is properly installed to avoid mechanical stresses, twisting or misalignment of equipment that may be exerted by clamps, supports and cabling.
- C. Thoroughly clean all areas and spaces where work is performed or used as access to work. Completely remove all paints, mortars, oils, or other residues and otherwise restore all surfaces to their original condition. Upon completion of the work, remove refuse and rubbish from, and about, areas of work. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.
- D. Grounding:
 1. Provide equipment grounding connections for all systems as indicated herein and in the Contract Documents. Ensure and demonstrate that resistance to solid earth for signals is less than or equal to three (3) ohms.
 2. In no event will the AC neutral conductor, either in a power panel or in receptacle outlets, be used for a reference ground.
 3. Ground all equipment in accordance with the manufacturers' requirements. Contractor will be responsible for diagnosis and correction of all problems related to improper grounding, including that which causes damage to equipment.
- E. All equipment will be installed square and plumb. Ensure that all equipment is clean and free of paint and other foreign materials.
- F. All installation practices will adhere to all applicable regulations, codes, ordinances, and standards as required by the LAHJ.
- G. Clearly identify points of connection for wiring from building power system to work of this section, and requirements for connection to materials and equipment supplied under other Sections of Work.
- H. Provide all transformers, relays and other accessories as required for a complete and operational system as defined herein and as required by the Security Subsystem Specifications. Furnish and install all fastenings, plates and other incidental items required for complete and operational installation.

- I. Labeling: All cables will be permanently labeled at their point of termination with mechanically produced labels. Label text will match that indicated on the record drawings.
- J. Contractor will ensure that all equipment installations and mounting are in strict accordance with requirements for applicable seismic classification.
- K. Prior to installation, ensure that each installation area meets the following conditions:
 - 1. All wet work is completed.
 - 2. Area is dust free.
 - 3. All work regarding painting is completed
- L. Anchor components securely in place, plumb, level, and accurately aligned. Provide separators and isolators to prevent corrosion and electrolytic deterioration.
- M. Protect installed equipment from damage and spoilage.
- N. Touch up minor scratches and abrasions with manufacturer's touch-up paint, as necessary.
- O. Double-sided foam tape will not be used to secure any terminal boxes, relay bases, or circuit boards, etc.
- P. All device mounting will be of a permanent nature.
- Q. During installation, care will be exercised at all times to protect Owner property.

3.3 COORDINATION

- A. Coordinate all Work to be performed with the General Contractor as necessary for smooth and expedient completion. Ensure critical path to completion where Work specified herein is dependent upon completion of Work by other trades or by Owner. Coordinate with other trades to avoid conflicts where Work in a certain area requires exclusive use of the area for the duration of the Work.
- B. Coordinate arrangement and quantity of security-related assemblies with ceiling space configuration and with other components occupying ceiling space, including structural members, ductwork, electrical raceways, lighting fixtures and other items.
- C. Furnish any inserts required for building into concrete, masonry, and other work to support and attach work of this section. Furnish in ample time to comply with schedule of work into which inserts are built.

3.4 SYSTEM STARTUP

- A. Subsequent to installation, clean each system component of dirt, dust, oils, and other residues incurred from project activities and prepare the system for activation by following each manufacturer's recommended procedures for adjustment, alignment, and synchronization.
- B. Program the system in accordance with the Owner's instructions and with the requirements of this Section.

3.5 SYSTEM TEST AND VERIFICATIONS

- A. Contractor will coordinate with Owner's Representative for final tests and inspections in the presence of the Owner and other representatives as the Owner's Representative deems appropriate.
- B. Contractor will develop a Final Test and Acceptance (FTAA) Plan. The plan will include the following components:
 - 1. Contractor will produce an item-by-item completion matrix indicating completion or incompleteness for each item included in this Section and any additional direction, addenda, or bulletins issued by the Owner's Representative. For each incomplete item, indicate the date of completion.
 - 2. The FTAA Plan will incorporate Owner-provided startup checklists and will follow the Owner standards.
 - 3. Contractor will perform a complete test of the systems installed to include visual inspections and operational tests of all components. Contractor will submit a report of the test to include system reports produced by the system software for each of the components tested and visual inspection reports for each component.
 - 4. FTAA Plan will identify each component of the system, intent of test, method or methods of test, and expected results. Each component listed in the plan will include space for test part signatures, brief comments, time of test, and pass/fail check boxes.
 - 5. The FTAA plan will be submitted to the Owner's Representative thirty (30) days prior to the scheduled final test.
- C. Contractor will ensure that the system is on and fully operational prior to the start of the test. Contractor will provide a minimum of two (2) employees to conduct the test, one of whom will operate software and other head-end equipment, while the other accompanies the Owner's Representative.
- D. Owner's Representative will observe a complete and thorough demonstration of the systems for compliance and issue a final report. Once all items in the report deemed non-operational or non-compliant with the Specification have been corrected and verified by the Owner's Representative the systems will be deemed acceptable.
- E. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective or failed equipment or installation to meet the requirements of these specifications and any extension of the observation and testing period is required, the Contractor shall pay for additional time and expenses of the Owner at the standard rate in effect at that time.
- F. Provide manufacturer's supervision of final testing of each system.
- G. Each system must test free from interference, opens, grounds, and short circuits.
- H. Following completion of the Final Test, the system will undergo a thirty (30) day Operational Demonstration Test (ODT) or Burn-In period. This operational demonstration period will start when all specified systems and equipment have been installed and "Substantial Completion" is reached, with no more than a moderate number of punch list items remaining. During this period, the system will be operated under a normal facility traffic load for no less than thirty

(30) days. If any item or system fails during the ODT, the 30-day burn-in period will be suspended for that item until repaired or replaced. Once repaired or replaced, the burn-in period will recommence. Final system acceptance of the entire project will be withheld until after successful completion of this operational demonstration period for all systems and components.

3.6 RECORD DOCUMENTATION

- A. Subsequent to completion, the Contractor will submit record documentation for the Project. Record documentation will consist of operation & maintenance manuals, As-Built drawings, and a document deviation log. All record documentation will be submitted in digital and hard copy format. Record documentation will meet the following requirements:
1. Digital format: Provide computerized disks, USB drive or compact disks as desired by Owner.
 2. Hard Copy: Provide a single copy, hard cover three ring binder for review purposes.
 3. Provide three (3) final hard copies each in hard covered three ring binder.
- B. Operations & Maintenance manuals will meet the following requirements:
1. Divide into sections for each system, clearly demarcated by a divider titled with the system:
 - a. Provide each divider with a tab.
 - b. Title each divider with machine print, no smaller than 12-point, to match tabs.
 2. Each section will be sub-divided into consistent sub-sections of information:
 - a. Provide each section with a table of contents.
 - b. Follow each table of contents with contact person information including their name, responsibility, phone number, and address.
 - c. Provide a section with a list of equipment, devices and components included in the section.
 - d. Include in the list the manufacturer, parts number, and contact person to call for questions on each item.
 - e. Follow the list provided with technical information on each listed item, in the order of the list:
 - 1) Product data sheets which include but are not limited to pictures, descriptions, dimensions, electrical diagrams, circuit board layouts, etc.
 - 2) Product specifications including but not limited to power requirements, operational criteria, environmental requirements, optical descriptions, etc.
 - f. Provide information related to the operation of equipment, devices, and components:
 - 1) Information provided will be specific to the product models actually installed on the project.
 - 2) Provide information as presented during the training sessions for each system provided for the facility.
 - g. Provide complete information required for care and maintenance of all equipment, devices, and components installed on the project. Information will include, but is not limited to:
 - 1) Cleaning: Special procedures or use of special chemicals.

- 2) Maintaining: Maintenance schedules and tasks, application of products critical to proper operation, types of environmental conditions which need to be maintained or avoided.
- 3) Trouble Shooting: Instructions for how to proceed should a problem occur, method of determining the seriousness of the problem, repair instructions for minor problems.
- h. Provide other Project Specific Information:
 - 1) List of wires, color codes, description of type, tag identification reference.
 - 2) As-Built drawings.
- i. Provide Operations & Maintenance manuals in accordance with the Project General Conditions or as specified in this Section. Where there are conflicts between the Project General Conditions and this Section, provide in accordance with the stricter requirements between the Sections:
 - 1) Where not addressed in other Sections, provide per this specification Section.
 - 2) See Security Subsystem Specifications for any additional requirements.

C. As-Built drawings will meet the following requirements:

- 1. As-Built drawings will consist of all information indicated under the section herein entitled “Shop Drawings” but updated to include the actual conditions encountered during installation.
- 2. As-Built drawings will indicate all cable pathways, termination box location(s), and other information related to above-ceiling or concealed equipment locations.
- 3. Contractor will provide drawings showing all changes occurring related to documents provided on the project directly related to this section, and all Security Subsystem Specification sections.
- 4. Contractor will provide scaled drawings of the same formatted size as those originally issued as contract drawings.
- 5. Changes will be indicated with referenced graphics that are properly noted:
 - a. Clouding will be bold, but without interfering with or obscure documentation information.
 - b. Notes will be alphabetically or numerically referenced.
 - c. Notations will not interfere with other information on the documents.
- 6. Drawings will be completed in a digital format using AutoCAD® Software. Version of files provided to be determined by the Owner’s Representative at the time that submittal of the information is required.

D. The document deviation log will meet the following requirements:

- 1. Contractor will provide a tracking log of changes made to the project that occurred that were in deviation of construction documents, and will be included:
 - a. Notification date: Provide day that Owner’s Representative was notified that a deviation was required or requested.
 - b. Approval Date: Provide the day that approval was provided by the Owner’s Representative.
 - c. Reason that deviation was required or made.
- 2. Provide drawings and photographs of all custom details, and details originally in the contract drawings that were modified:

- a. Drawings to be submitted on 8 ½-inch x 11-inch sheets or larger.
- b. Provide photos that are 5-inch x 7-inch in size or larger. Photographs will be clear, focused, and taken with the proper light:
 - 1) All details will be clearly visible.
 - 2) All text will be legible.

3.7 ACCEPTANCE

- A. System Warranty will not start until Acceptance. Acceptance will be withheld until the following activities have been successfully completed:
 1. Acceptance of all submittals.
 2. Delivery of final documentation.
 3. Successful final test and inspection.
 4. Successful operational demonstration test.
 5. Successful training and demonstration, including operation of systems using the manuals.
- B. System Contractor will be present at the first use of the facility. The Contractor will be on site the day before the event in addition to the day of the event. The event will be decided by the operators as to which one the systems Contractor should attend.

3.8 WARRANTY

- A. In addition to all guarantees specified in the Project General Conditions and specific Warranty requirements stated in the Security Subsystem Specifications, furnish the following warranty:
 1. Period: The Contractor will guarantee all labor, workmanship, and materials for a period of one (1) year from the date of Final Acceptance. Should failure occur within the first year to the system, the Contractor will provide all labor and materials necessary to restore the system to the condition required for the final test and acceptance at no cost to the Owner.
 2. Tie-ins: During the Warranty period, additional components may be connected to the installed systems. New devices will be connected in the same manner as shown in the Contract Documents and the existence of the new connections will not void this guarantee. Where software is part of the system, new information will be entered in the database to extend operation of the system.
- B. Contractor shall respond to a request for assistance within four (4) hours of receipt and have the repair completed, or temporality repaired, to the satisfaction of the Owner within 24-hours during the warranty period at no additional cost to the Owner. After-hours service will be available within the four (4) hour window, whether or not the Owner elects to purchase a service contract from the Contractor.
- C. Contractor's guarantee will include all costs related to troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, materials, equipment, and other costs as necessary to restore the system to a complete and operational state:
 1. The Owner must not be without an operational system or component of the system should it require a return to the factory for repair or replacement. It will be the responsibility of the Contractor to replace the component during the 24-hour time period outlined above.

- D. Contractor will provide local service by factory trained personnel from an authorized dealer of the equipment manufacturer. Contractor will provide written proof from the equipment manufacturer that said Contractor is duly authorized to sell, service and maintain the specified products. The dealer will have available stock of the manufacturer's standard parts for the primary system components and devices. The dealer will provide sufficient parts in inventory or readily available such that repair will be completed in no more than 24-hours. The inventory of spare parts requirement is assuming availability of components through a dealer network and/or obtained from respective manufacturers within the required time frame.
- E. The Contractor will offer an "Optional Three (3) Year Maintenance after Warranty" and an "Optional Five (5) Year Maintenance after Warranty" package to the Owner containing price, terms, and conditions shown for each year. The Owner will inform the Contractor of the acceptance or rejection of the package prior to the end of the warranty period.
- F. Contractor will correct any software or firmware defects identified during the Warranty period without additional cost to the Owner.
- G. This warranty will be in addition to, and not a limitation, of other rights the Owner may have under the Contract Documents.
- H. Contractor will warrant that all Work furnished in this project will be of good quality, free from faults and defects, and in conformance with the Contract Documents.

END OF SECTION 28 05 00

SECTION 28 05 13
CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including all General and Supplementary Conditions and Division 1 Specification sections, shall apply to this section and shall be considered as forming an integral part of this Work. These documents are referred to as the Project General Conditions in the remainder of these Specifications.
- B. The Common Work Results for Electronic Security Section shall apply to Work specified in this Section. Where similar requirements headings are listed herein, they are to augment the requirements indicated within the Common Work Results for Electronic Security Section. Nothing herein shall be construed as relieving the Contractor from the requirements identified in the Common Work Results for Electronic Security Section.
- C. Not all cables shown within this section will be used on this project.
- D. The following sections are related and have interaction between them:
 - 1. 28 05 00 Common Work Results for Electronic Security
- E. Other related sections:
 - 1. Division 07 Firestopping
 - 2. Division 08 Door Hardware
 - 3. Division 26 Electrical
 - 4. Division 27 Structured Cabling System

1.2 DEFINITIONS

- A. AWG: American Wire Gauge

1.3 REFERENCES

- A. National Electrical Code (NEC)
- B. NFPA 70
- C. UL 294 and UL 1076 as required where applicable
- D. FCC Rules and Regulations
- E. Part 15 Class A or B as applicable
- F. Applicable Federal, State, and Local laws, regulations, and other codes
- G. CE mark, as and where applicable
- H. C-Tick mark, as and where applicable

1.4 SUMMARY OF WORK

- A. Work specified in this Section includes cables used for security systems.

1.5 SUBSTITUTION

- A. Refer to Section 28 05 00 Common Work Results for Electronic Security.

1.6 SUBMITTALS

- A. Refer to Section 28 05 00 Common Work Results for Electronic Security.

PART 2 - PRODUCTS

2.1 GENERAL

- A. “Or approved equal” basis
 1. The products are listed on an “approved equal” basis. The known equals to the products specified are listed in each section.
 2. Substitute products not listed in this section may be submitted for approval during the question-and-answer period of the bidding phase. See substitution requirements in this section.
 3. Substitution approvals will be based on the complete functionality, integration, operation, and user interface as it compares to the specified product(s).
 4. Products not approved prior to the bidding phase will be deemed non-responsive.
- B. Pathway shall follow structured cabling Division 27 standards.
- C. Provide Wet Rated Cable as required due to project raceways/pathways.

2.2 MISCELLANEOUS EQUIPMENT

- A. Demarcation Enclosure for Wet to Dry rated cabling
 1. Provide a Nema 3R rated enclosure with hinge, horizontally swinging lid, and cam lock.
 2. Size the enclosure as needed for the contents.
 3. Enclosure contents shall be:
 - a. Phoenix Perforated NS 35/7,5 DIN rail to support DIN rail mounted items.
 - b. Terminal Block and Accessories
 - 1) DIN rail mounted Phoenix universal screw terminal block model UT 2,5 BU (quantity as needed).
 - 2) DIN rail mounted Phoenix ground modular terminal block model UT 2,5 GN (quantity as needed).
 - 3) End clamp model CLIPFIX 35-5 (quantity as needed).
 - c. Zack marker strips model ZB 5 (quantity as needed).
 - d. Contractor shall label each terminal block to indicate its purpose and use.
 - e. Contractor shall provide quantities as needed to provide one wire per terminal.

2.3 CABLES AND WIRING

- A. 18 AWG, 6 Conductor Stranded Overall Shield (Type A)
 - 1. Provide Windy City Wire 442351 (Plenum)
 - 2. Known equals:
 - a. Superior Essex
 - b. Belden
 - c. Bertek
 - d. Commscope
 - e. General
 - 3. Wet Rated Cable
 - a. Windy City Wire 714410VNQ
 - b. Approved equal.

- B. 18 AWG, 4 Conductor Stranded Unshielded (Type B)
 - 1. Provide Windy City Wire 442380 (Plenum)
 - 2. Known equals:
 - a. Superior Essex
 - b. Belden
 - c. Commscope
 - d. General
 - 3. Wet Rated Cable
 - a. Windy City Wire 727310VNQ
 - b. Approved equal.

- C. 16 AWG, 2 Conductor Stranded Unshielded (Type C)
 - 1. Provide Windy City Wire 441360 (Plenum)
 - 2. Known equals:
 - a. Superior Essex
 - b. Belden
 - c. Commscope
 - d. General
 - 3. Wet Rated Cable
 - a. Windy City Wire 728110VNQ
 - b. Approved equal.

- D. 18 AWG, 2 Conductor Stranded Shielded with drain (Type E)
 - 1. Provide Windy City Wire 442320 (Plenum)
 - 2. Known equals:
 - a. Superior Essex
 - b. Belden
 - c. Commscope
 - d. General
 - 3. Wet Rated Cable
 - a. Windy City Wire 714110VNQ
 - b. Approved equal.

- E. Composite Access Controlled Door Cable (Type F)
 - 1. Provide Windy City Wire 4461230 (Plenum)
 - 2. Known equals:

- a. Superior Essex
- b. Belden
- c. Commscope
- d. General
- e. West Penn
- f. Honeywell
- 3. Wet Rated Cable
 - a. Windy City Wire 4461111WBT
 - b. Approved equal.
- F. Composite Copper Fiber (Type J)
 - 1. Coordinate provisioning of Composite Copper Fiber cable per Owner/Division 27 standards.
- G. Network Communication Cable (Type M)
 - 1. Coordinate provisioning of Category cable per Owner/Division 27 standards.

PART 3 - EXECUTION

3.1 LABELING

- A. Provide labeling in accordance with TIA/EIA 606-A Level 2 numbering and ID format.
- B. Mechanically print and install in accordance with manufacturer recommendations and drawing details.
- C. Labels shall be single line, all capital letters, and bold font. Select font size and color that can be easily read on the applicable device or cable during installation, inspection, and for service maintenance.
- D. Ensure all surfaces are clean prior to final placement of labeling products. Follow manufacturer recommendations for cleaning.
- E. Handwritten labels are unacceptable.
- F. Provide labeling as required for the following:
 - 1. Horizontal and Backbone cabling:
 - a. Locate the cable designator within 4-inches of the point of termination at the workstation end of the horizontal cable.
 - b. Locate the cable designator within 12-inches of the end of the cable jacket at the TR end of the horizontal cable.
 - c. Locate the cable designator within 12-inches of the end of the cable jacket for backbone terminations utilizing rack-mount patch panels or blocks.
 - d. Locate the cable designator within 12-inches of the end of the cable jacket for backbone terminations utilizing wall-mount patch panels or blocks.
 - e. Junction boxes, pull boxes, HCP's.
 - f. Termination patch panels and blocks.
 - g. Grounding and bonding equipment.
 - h. Equipment cabinets, racks, frames, and enclosures.

- i. Locate lamacoid labels on the front and rear of equipment cabinets at the top of the cabinet doors. For cabinets equipped with removable doors, one additional pair of labels shall be located on the inside top of the frame.
 - j. Locate lamacoid labels on the front and rear of equipment racks attached to the top horizontal cross-members.
 - k. Locate lamacoid labels on the top horizontal cross-member of wall-mount frames.
- G. Provide machine generated labels for each system associated with the Electronic Security System to include, but not limited to, the following:
 - 1. Conduit pathways including:
 - a. Junction boxes
 - b. Pull boxes
 - c. Horizontal connection points
 - d. Conduit
 - e. Cable tray
 - f. Grounding busbars
 - g. Voltage protection equipment
- H. Provide machine generated labels for each component associated with the Electronic Security System to include, but not limited to, the following:
 - 1. Access Control Panels
 - 2. Cameras
 - 3. Readers
 - 4. Door Contacts
 - 5. Termination blocks
 - 6. Patch panels
 - 7. Equipment cabinets, racks, frames, and enclosures
 - 8. Power distribution units, power strips
- I. Provide machine generated labels for each cable associated with the Electronic Security System to include, but not limited to, the following:
 - 1. Copper backbone cables
 - 2. Fiber optic backbone cables
 - 3. Horizontal premise cables
 - 4. Grounding and bonding conductors
- J. Provide lamacoid labels for specified equipment.
- K. Provide machine generated placards as specified for each technical enclosure.
- L. Provide labeling materials designed for a lifetime equal to the system, component or cable being identified.
- M. Provide labels on the face of wall mount equipment and on the wall adjacent to the equipment.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 28 05 00 Common Work Results for Electronic Security.

3.3 SYSTEM TEST AND VERIFICATION

- A. Refer to Section 28 05 00 Common Work Results for Electronic Security.

3.4 WARRANTY

- A. Refer to Section 28 05 00 Common Work Results for Electronic Security.

3.5 COORDINATION

- A. Coordinate custom SCS report requirements. Submit report templates to the Owner's Representative for review and acceptance.

END OF SECTION 28 05 13

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM

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 design and provision of a new, complete, multiplex/addressable fire alarm system as described herein and on the Contract Drawings. The system shall include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. The system layout on the drawings is generic.
- B. Extent of the Work: The system shall be installed in accordance with the drawings, specifications and referenced publications.
- C. Existing Fire Alarm Equipment: Existing fire alarm equipment shall be maintained fully operational until the new equipment has been tested and accepted by the Owner. As new equipment is installed, it shall be labeled "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Owner it shall be placed in service and connected to a UL listed central station service. All new equipment shall have tags removed and the existing equipment shall be tagged "NOT IN SERVICE" until removed from the building.
- D. Equipment Removal: After acceptance of the new system by the Owner, all existing equipment not connected to the new system shall be removed and all damaged surfaces shall be restored. The material shall be removed from the site and disposed of by the Contractor.
- E. Repair Service/Replacement Parts: Repair services and replacement parts for the system shall be furnished under this contract and be available for a period of 10 years after the date of final acceptance of this work by the Owner. On-site service during the guarantee period shall be provided within 24 hours after notification. All repairs shall be completed within 48 hours after notification.
- F. Section Includes:
 - 1. Fire-alarm control unit (Existing - For Reference Only)
 - 2. Manual fire-alarm boxes
 - 3. System smoke detectors
 - 4. System Carbon Monoxide Detectors
 - 5. System Multi-Criteria detectors
 - 6. Nonsystem smoke detectors

7. Heat detectors
8. Notification appliances
9. Firefighters' two-way telephone communication service
10. Magnetic door holders
11. Amplifiers, pre-amplifiers, and tone generators
12. Remote annunciator
13. Addressable interface device
14. Digital alarm communicator transmitter
15. Device guards

1.3 REFERENCES AND REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

- A. Codes and Standards: The fire alarm equipment and installation shall conform to the requirements of all applicable codes, rules, regulations and standards, including, but not limited to, the following:
 1. 2018 North Carolina State Building Code
 2. 2018 North Carolina Existing Building Code
 3. 2018 North Carolina Fire Prevention Code
 4. 2020 North Carolina State Electrical Code (NFPA 70 – 2020)
- B. NEMA ICS-6: Enclosures for Industrial Control and Systems
- C. NICET: National Institute for Certification in Engineering Technologies

1.4 DEFINITIONS

- A. Alarm Signal: A signal which indicates a state of emergency requiring immediate notification of the fire department and of the building occupants. These are signals such as the operation of a manual pull station, the activation of a smoke detector with alarm-verification feature, the activation of a waterflow switch in a sprinkler system, a fire pump running switch, or the operation of a pressure switch in a fire suppression system caused by the flow of fire extinguishing agent.
- B. Class A Wiring: A circuit that is monitored for integrity such that a single break, a single wire-to-wire short, or a single loss of carrier condition will be indicated by a trouble signal on the FACP no matter where the break, short or loss of carrier condition occurs. This circuit will allow all functions of the affected circuit to remain operational in the event of a single open or single ground. In accordance with NFPA 72, this would be Style 6, Class A wiring for signaling line circuits, Style 7 Class A wiring for network circuits, and Class A wiring for Initiating Device Circuits and for Notification Appliance Circuits.
- C. Class B Wiring: A circuit that is monitored for integrity such that a single break, a single wire-to-wire short, or a single loss of carrier condition will be indicated by a trouble signal on the FACP no matter where the break, short or loss of carrier condition occurs, but which would prohibit devices beyond the fault, short or carrier loss from remaining operational. In accordance with NFPA 72, this would be Style 4, Class B wiring for signaling line circuits and Class B wiring for, initiating device circuits and notification appliance circuits.

- D. Fire Alarm Control Panel (FACP): A master control panel having the features of a fire alarm control unit and to which all fire alarm control units are interconnected. The panel has central processing, memory, input and output terminals, and video display units (VDUs).
- E. Initiating Device: A system component that originates transmission of a change of state condition, which initiates an appropriate response via the fire alarm system.
- F. Initiating Device Circuit: A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.
- G. Interface Device: An addressable device which interconnects hard wired systems or devices to a multiplex system.
- H. Install: To set in position and connect or adjust for use.
- I. LED: Light-emitting diode.
- J. Manual Pull Station: A fire alarm box as indicated in NFPA 72.
- K. Monitor/Control Modules: Addressable fire alarm devices installed to provide supervised monitoring or control of accessory equipment.
- L. Multiplex System: A system in which multiple signals are transmitted via the same conduction path to a remote fire alarm control unit and fire alarm control panel, decoded and separated so that each signal will initiate the specified response.
- M. NICET: National Institute for Certification in Engineering Technologies.
- N. Notification Appliance Circuit: A circuit to which notification appliances are connected to visually and audibly indicate an alarm signal.
- O. Pathway Survivability
 - 1. Level 1. Pathway survivability Level 1 shall consist of pathways in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, with any interconnecting conductors, cables, or other physical pathways installed in metal raceways.
 - 2. Level 2. Pathway survivability Level 2 shall consist of one or more of the following:
 - a. 2-hour fire-rated circuit integrity (CI) cable
 - b. 2-hour fire-rated cable system electrical circuit protective system(s)
 - c. 2-hour fire-rated enclosure or protected area
 - d. 2-hour performance alternatives approved by the authority having jurisdiction
 - 3. Level 3. Pathway survivability Level 3 shall consist of pathways in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, and one or more of the following:
 - a. 2-hour fire rated circuit integrity (CI) cable
 - b. 2-hour fire rated cable system (electrical circuit protective system(s))
 - c. 2-hour fire rated enclosure or protected area

- d. 2-hour performance alternatives approved by the authority having jurisdiction
- P. Provide: To furnish and install the stated equipment or materials.
- Q. Remote Fire Alarm Control Unit: A control panel, remote from the fire alarm control panel, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm control panel.
- R. Signaling Line Circuit: A circuit to which any combination of circuit interfaces, control units, or transmitters are connected and over which multiple system input signals or output signals, or both, are carried.
- S. Supervisory Signal: A signal which indicates the impairment of a fire protection system which may prevent its normal use. These are signals from switches, such as a tamper switch, a fire pump phase reversal switch, or a fire pump loss of phase switch.
- T. Tamper Switch: A valve monitor switch as indicated in NFPA 72.
- U. Terminal Cabinet: A steel cabinet with locking, hinge-mounted door in which terminal strips are securely mounted. Minimum size is 8 inch x 8 inch.
- V. Trouble Signal: A signal which indicates that a fault, such as an open circuit or ground, has occurred in the fire alarm system or in a separate subsystem, whose control panel is monitored by the fire alarm system.

1.5 SYSTEM DESCRIPTION

- A. General: System shall be a complete, supervised, noncoded, UL-certified addressable system fire alarm system with multiplexed signal transmission. System shall conform to NFPA 72. The system shall have an interconnected riser loop or network having Class X supervision. The return portion of the loop shall be remote from the supply portion of the loop. The system shall have Style 4 Class B circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal. The system shall provide the following functions and operating features:
 - 1. The FACP and fire alarm control units shall provide power, annunciation, supervision and control for the system.
 - 2. Provide Class B initiating device circuits.
 - 3. Provide Style 4 Class B signaling line circuits for each floor.
 - 4. Provide Style 7 Class A signaling line circuits for the network.
 - 5. Provide Class B notification appliance circuits.
 - 6. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
 - 7. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault which prevents the required operation of the system. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a

- trouble alarm silence feature which will silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.
8. Provide a notification appliance silencing switch which, when activated, will cause the notification appliances to cease operating, but not affect the liquid crystal display or the automatic notification of the central station service. This switch shall be overridden upon activation of a subsequent alarm.
 9. Provide alarm verification capability for area smoke detectors.
 10. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, air handler shutdown, features. Operation of this programming shall indicate this action on the FACP display and printer output.
 11. All alarm, supervisory, or trouble signals shall be automatically transmitted to a UL listed central station.
 12. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
 13. The system shall be capable of being programmed in the field. All programmed information shall be stored in nonvolatile memory.
 14. The system shall be capable of operating, supervising, and/or monitoring both addressable and nonaddressable alarm and supervisory devices.
 15. There shall be no limit, other than maximum system capacity, as to the number of addressable devices which may be in alarm simultaneously.
 16. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system, the addressable fire alarm relay shall be within 3 feet of the emergency control device.
 17. An alarm signal shall automatically initiate the following functions:
 - a. Transmission of an alarm signal to a UL listed Central Station.
 - b. Visual indication of the device operated on the fire alarm control panel (FACP), video display unit (VDU). Indication on the graphic annunciator shall be by floor, zone or circuit, and type of device.
 - c. Operation of a duct smoke detector shall shut down the appropriate air handler and/or smoke damper(s) in accordance with the International Mechanical Code and NFPA 90A.
 - d. Operation of a heat detector or a sprinkler waterflow switch in an elevator machinery room shall operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ANSI A17.1.
 18. A supervisory signal shall automatically initiate the following functions:
 - a. Transmission of a supervisory signal to a UL listed Central Station.
 - b. Visual indication of the device operated on the fire alarm control panel (FACP), video display unit (VDU), and on the graphic annunciator.
 19. A trouble condition shall automatically initiate the following functions:
 - a. Transmission of a trouble signal to a UL listed Central Station.
 - b. Visual indication of the system trouble on the FACP, VDU, and on the graphic annunciator.
 - c. Recording of the event via the system printer.

20. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP shall be fifteen seconds.
21. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP shall not exceed 200 seconds.
22. A Positive-Alarm-Sequence in accordance with NFPA 72 shall be utilized.

1.6 PERFORMANCE REQUIREMENTS

A. System Monitoring:

1. Valves: Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, and valves at backflow preventers, whether supplied under this contract or existing, shall be monitored to ensure its proper position. Each tamper switch shall be provided with a separate address. Tamper switches shall be furnished and installed by Division 21 and connected to the fire alarm system by Division 28.

B. Overvoltage and Surge Protection

1. Signaling Line Circuit Surge Protection: For systems having circuits located outdoors, all communications equipment shall be protected against surges induced on any signaling line circuit. All cables and conductors, which serve as communications links, shall have surge protection circuits installed at each end.
2. Sensor Wiring Surge Protection: All digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors.

1.7 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. The fire alarm equipment distributor shall submit, in accordance with Division 1 requirements, documentation as specified in the Quality Assurance portion of this Section. When the distributor intends to utilize the services of a manufacturer-affiliated company in the system design, the distributor shall submit a letter of intent to do so, addressed to the Architect, which includes the name of the manufacturer-affiliated company, the names and qualifications of the NICET-certified employees of the company, and which describes the delegation of fire alarm system design responsibilities.
3. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.
 - d. Drawings and Calculations to be sealed by a registered Professional Engineer in the project State.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Provide point-to-point wiring diagrams showing the points of connection and terminals used for all electrical field connections in the system, including all interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams shall show all connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals. Provide isometric drawing showing device locations, terminal cabinet locations, and all circuit layouts for all floors. Submit shop drawings not smaller than 30 inches by 42 inches. Shop drawings shall be prepared on a Computer Aided Drafting (CAD) system.
3. Provide a complete description of the system operation.
4. Provide a complete list of devices, device addresses, and corresponding messages.
5. Include voltage drop calculations for notification appliance circuits.
6. Include battery-size calculations.
7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
9. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
10. Include annotated catalog data showing manufacturer's name, model, voltage, and catalog numbers for all equipment and components. Where multiple configurations of equipment or options are available, indicate specific configuration being submitted.
11. Provide complete battery calculations for both the alarm and supervisory power requirements. Ampere-hour requirements for each system component shall be submitted with the calculations.
12. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Provide a color code schedule for the wiring.
13. Provide floor plans showing the location of all devices and equipment. Show locations for all conduit and for all junction boxes used for T-taps. Indicate conduit fill percentages on the plans.
14. Provide data on each circuit to indicate that there is at least 25% spare capacity for notification appliances, 25% spare capacity for initiating devices. Provide circuit numbers for audible devices and load calculations for each circuit.
15. Provide a schedule of initiating device addresses and indicating device zones and subzones.
16. Include submittal data for all wire, terminal cabinets, and raceways.
17. Provide data to indicate that the amplifiers have sufficient capacity to simultaneously drive all fire alarm speakers at their highest tap setting plus 25% spare capacity.
18. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal:

1. For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

- E. Qualification Data: For qualified Installer.

- F. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- G. Field quality-control reports.

- H. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Provide bound copies of an operation and maintenance manual. The manual shall include an index, copies of all approved shop drawings and submittal materials updated to "As Built", and a complete parts list of all components. The manual shall also include a list of recommended spare parts. The spare parts list shall include, for each item, the manufacturer's name, the serial number of the part, an ordering number, if appropriate, and a physical and electrical description of the part. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Prepare and submit detailed CAD-based "As-Built" drawings. The drawings shall include complete plan view wiring diagrams showing connections between all devices and equipment, both factory and field wired, including, but not limited to, locations for all conduit and for all junction boxes used for T-taps. Indicate conduit fill percentages on the plans. All equipment in panels shall be shown in the as-built orientation. Include a riser diagram and drawings showing the as-built location and address or circuit number of all devices and equipment.
 2. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 4. Record copy of site-specific software.
 5. Matrix of Operations including all system inputs and outputs.
 6. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components
 - b. Frequency of inspection of installed components
 - c. Requirements and recommendations related to results of maintenance.

- d. Manufacturer's user training manuals
 - 7. Manufacturer's required maintenance related to system warranty requirements.
 - 8. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - 9. Include an electronic copy of the programming on CD for use by the Owner.
 - 10. Copy of NFPA 25.
- I. Software and Firmware Operational Documentation:
- 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be accomplished by a Contractor with a minimum of five years' experience in the installation of fire alarm systems. Contractor shall show evidence of certification of at least one employee directly responsible for the work by the National Institute for Certification in Engineering Technologies (NICET) at Level II, III, or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology. Any proposed installer who cannot show evidence of such qualifications may be rejected. The services of a technician provided and certified by the control equipment manufacturer shall be provided to supervise installation adjustments and tests of the system. Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Distributor Qualifications:
- 1. The manufacturer's equipment distributor shall show evidence of certification by the manufacturer in the technical support of the system installed under this contract.
 - 2. The distributor shall show evidence of certification of at least one employee by the National Institute for Certification in Engineering Technologies (NICET) at Level III or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of an existing employee. At a minimum, comparable training and experience shall consist of five years of progressive experience in the installation and design of fire alarm systems of similar size and complexity to that specified herein
 - 3. In lieu of an employee with NICET Level III or IV certification, the distributor shall show evidence of at least one employee with a minimum of three years of progressive experience in the design of fire alarm systems and, in addition, the distributor shall show evidence of technical support in the design, installation, and testing of the systems from a manufacturer-affiliated company, which shall show evidence of certification of at least one employee by the National Institute for Certification in Engineering Technologies (NICET) at level III or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology
- C. Manufacturer Qualifications:
- 1. Testing Services or Laboratories: Construct all fire alarm and fire detection equipment in accordance with the latest edition of the following publications from Underwriters Laboratories (UL) and Factory Mutual Engineering Corporation (FM).

2. UL Fire Protection Equipment Directory
3. UL Electrical Construction Materials Directory
4. UL 464 - Audible Signal Appliances
5. UL 864 - Control Units for Fire Protective Signaling Systems
6. UL 1480 - Speakers for Fire Protective Signaling Systems
7. UL 1971 - Signaling Devices for the Hearing Impaired.
8. Factory Mutual Approval Guide.

- D. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- E. 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.
- F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.10 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
 3. Keys and Tools: One extra set for access to locked and tamperproofed components. Keys and locks for all equipment shall be identical where possible. Provide not less than six keys of each type required. Identify keys by an appropriate number stamped on each key or on a metal tag attached thereto. Provide a key numbering chart in each operation and maintenance manual furnished.
 4. Audible and Visual Notification Appliances: One of each type installed.
 5. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products to match existing.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by Bosch Security Systems or comparable product by one of the following:
 1. Faraday.
 2. Fike Corporation.
 3. Fire-Lite Alarms.
 4. GAMEWELL.
 5. GE UTC Fire & Security; A United Technologies Company.
 6. Notifier.
 7. Siemens Industry, Inc.; Fire Safety Division.
 8. Silent Knight.
 9. SimplexGrinnell LP.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 1. Manual stations
 2. Heat detectors
 3. Flame detectors
 4. Smoke detectors

- [Duct smoke detectors
- 5. Automatic sprinkler system water flow
- 6. Fire-extinguishing system operation
- 7. Fire standpipe system

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Recall elevators to primary or alternate recall floors.
10. Activate emergency lighting control.
11. Activate emergency shutoffs for gas and fuel supplies.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.
4. Duct smoke detectors.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT (EXISTING TO REMAIN)

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

- a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Circuits:
1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
 - a. Initiating Device Circuits: Class B
 - b. Notification Appliance Circuits: Class B
 - c. Signaling Line Circuits: Class B
 - d. Each circuit shall be provided with 25% spare capacity.
 2. Serial Interfaces: Two RS-232 ports for printers.
 3. Pathway Survivability. Emergency Communication Systems - Pathway survivability levels shall be as required in NFPA 72. Notification and communication circuits required to ensure operation of the emergency communication system shall meet the following:
 - a. In-building fire emergency voice/alarm communications systems shall either
 - 1) For systems employing relocation or partial evacuation require, a Level 2 or 3 pathway survivability shall be required.
 - 2) For systems that do not employ relocation or partial evacuation a Level 0 through 3 pathway survivability shall be required.
 - b. In-building mass notification systems shall have a Level 0 pathway survivability
 - c. Two-way in-building wired emergency communications systems shall have a pathway survivability of Level 2 or Level 3.
 - d. Two-way radio communications enhancement systems used in lieu of a two-way in-building wired emergency communications system, it shall have a pathway survivability of Level 2 or 3.

- e. Area of refuge (area of rescue assistance) emergency communications systems shall have a pathway survivability of Level 2 or 3. Circuits intended to transmit off-premises shall have a pathway survivability of Level 0 through 3.
- D. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
 - 1. Pressurization starts when any alarm is received at fire-alarm control unit.
 - 2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
- E. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3. Record events by the system printer.
 - 4. Sound general alarm if the alarm is verified.
 - 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- F. Notification Appliance Circuit: Operation shall sound in a slow whoop pattern.
- G. Elevator Recall:
 - 1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
 - 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 - 3. Heat detector in an elevator shaft or elevator machine room shall shut down elevators associated with the location.
- H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.
- J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

- K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.
1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. A fire alarm shall activate a slow whoop or other tone for three cycles followed by a voice message which is repeated until the control panel is reset. Automatic messages shall be broadcast through all speakers. A live voice message shall override the automatic. When using the microphone, live messages shall be broadcast through speakers throughout the building. The system shall be capable of operating all speakers at the same time. The digitized voice message shall consist of a nonvolatile (EPROM) microprocessor based input to the amplifiers. The microprocessor shall actively interrogate all circuitry, field wiring and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power or any other malfunction which could render the digitized voice module inoperative shall automatically cause the slow whoop tone to take over all functions assigned to the failed unit.
 - d. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - e. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch. Provide the battery powered secondary power system with sufficient capacity to operate the complete alarm system in normal or supervisory (nonalarm) mode for a period

of 24 hours. Following this period of operation on battery power, the batteries shall have sufficient capacity to operate the system during a fire or other emergency condition for a period of 5 minutes. Fifteen minutes of evacuation alarm operation at maximum connected load shall be considered the equivalent of 2 hours of emergency operation.

1. Batteries: Sealed, valve-regulated, recombinant lead acid Sealed lead calcium.

O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Stations shall be supplied with screw terminals for making connections.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
6. Detectors shall have alarm verification capability and environmental compensation feature.
7. Smoke detectors shall be listed for use with the fire alarm control panel.
8. Provide self-restoring type detectors which do not require any readjustment after actuation to restore it to normal operation.

9. All detectors shall have an insect screen and, as required, one set of auxiliary contacts, one each normally open and normally closed (Form "C").
10. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status
 - b. Device type
 - c. Present average value
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.)

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status
 - b. Device type
 - c. Present average value
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.)

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status
 - b. Device type
 - c. Present average value
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.)

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Duct smoke detectors shall be furnished, wired and programmed by the Division 28 contractor and installed by the Division 23 contractor. The Division 28 contractor shall coordinate sampling tube sizes and locations with Division 23.
5. Each sensor shall have multiple levels of detection sensitivity.
6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
7. All duct smoke detectors located above finished ceilings or otherwise hidden from view shall be furnished with remote alarm indicator lamps, identification nameplates, and test stations. Do not locate test stations in finished corridor ceilings or walls. Install test stations in nearest mechanical or electrical room.
8. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Aspiration Type Smoke Detectors: complying with UL 268.

1. It shall consist of an air sampling pipe network to transport air to the detection system, supported by calculations from a computer-based design modeling tool.
2. Shall be approved to provide very early smoke detection and provide four output levels corresponding to Alert, Action, Fire 1 and Fire 2. These levels shall be programmable and able to be set at sensitivities ranging from 0.005 – 20% obsc/m.
3. Shall report any fault on the unit by using configurable fault output relays.
4. Shall be self monitoring for filter contamination.
5. Shall incorporate a flow sensor in each pipe and provide staged airflow faults.
6. Sampling Pipe:
 - a. The sampling pipe shall be smooth bore with an internal diameter between 15-25mm. Normally, pipe with an outside diameter of 25mm and internal diameter of 21mm should be used.
 - b. The pipe material should be suitable for the environment in which it is installed or should be the material as required by the specifying body.
 - c. All joints in the sampling pipe must be airtight and made by using solvent cement, except at entry to the detector.
 - d. The pipe shall be identified as Aspirating Smoke Detector Pipe (or similar wording) along its entire length at regular intervals not exceeding the manufacturer's recommendation or that of local codes and standards.
 - e. All pipes should be supported at not less than 1.5m centers, or that of the local codes or standards.
 - f. The far end of each trunk or branch pipe shall be fitted with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

2.6 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.

4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.7 MULTICRITERIA DETECTORS

- A. Mounting: Adapter plate for outlet box mounting. Twist-lock base interchangeable with smoke-detector bases.
- B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
- D. Test button tests all sensors in the detector.
- E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 1. Primary status.
 2. Device type.
 3. Present sensitivity selected.
 4. Sensor range (normal, dirty, etc.).
- F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.
 1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
 2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
 3. Heat sensor shall be as described in "Heat Detectors" Article.
 4. Each sensor shall be separately listed according to requirements for its detector type.

2.8 NONSYSTEM SMOKE DETECTORS

- A. Single-Station Smoke Detectors:
 1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 2. Auxiliary Relays: One Form C rated at 0.5 A, Form A and one Form C, both rated at 0.5 A.
 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 4. Visible Notification Appliance: 177-cd strobe.
 5. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.

6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

B. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot when tested according to UL 268A.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.9 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 1. Mounting: Adapter plate for outlet box mounting. Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 1. Mounting: Adapter plate for outlet box mounting. Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Continuous Linear Heat-Detector System:

1. Detector Cable: Rated detection temperature 155 deg F. NRTL listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short-circuit wires at the location of elevated temperature.
2. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output: field selectable to 15/30/75/110 cd, set as shown on drawings.
2. Mounting: Wall/ceiling mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, white or red. See drawings for color preference.

D. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. Field selectable wattage taps from ¼ to 2 watts. Setting determined by contractor's final certification / test.
3. Mounting: surface mounted and bidirectional.
4. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.11 AMPLIFIERS, PRE-AMPLIFIERS, AND TONE GENERATORS

- A. General: Any amplifiers, preamplifiers, tone generators, digitized voice drives and all other hardware necessary for a complete, operational voice/alarm signaling service conforming to NFPA 72 shall be housed in a remote fire alarm control unit at the locations shown on the drawings, terminal cabinet, or in the fire alarm control panel. The system shall automatically operate and control all building fire alarm speakers.
- B. Construction: All amplifiers shall utilize computer grade solid-state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to ten (10) times the highest rated voltage in the system.
- C. Inputs: Each system shall be equipped with separate inputs from the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.
- D. Tone Generator: The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a slow whoop, high/low, horn, chime, beep, stutter, wail, and bell tones as directed by the Owner and be constantly repeated until interrupted by either the digitalized voice message, the microphone input or the alarm silence mode as specified. Each slow whoop cycle shall last approximately four (4) seconds. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.
- E. Protection Circuits: Each amplifier shall be constantly supervised for any condition which could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer and other actions for trouble conditions as specified.

2.12 ADDRESSABLE INTERFACE DEVICE

- A. Monitor Module Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts. Addressable monitor module shall provide an individual address for each device below using a supervised Class B circuit:
 - 1. Sprinkler Waterflow: Paddle type switch
 - 2. Sprinkler/standpipe valve supervisory switch
 - 3. Each nonaddressable initiating device
- B. Control Module Description: Addressable control module shall provide normally-open, normally-closed Form C contacts for auxiliary control purposes. Integral Relay: Capable of providing a direct signal. All activation and power circuits required shall be provided from the fire alarm system for the following:

1. Air Handler Shutdown: Provide addressable control module as a separate or integral component of the air handler duct smoke detectors required by Division 23. Control wiring between control module and air handler control unit shall be provided by Division 23, with coordination through the General Contractor.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 1. Verification that both telephone lines are available.
 2. Programming device.
 3. LED display.
 4. Manual test report function and manual transmission clear indication.
 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 1. Address of the alarm-initiating device.
 2. Address of the supervisory signal.
 3. Address of the trouble-initiating device.
 4. Loss of ac supply or loss of power.
 5. Low battery.
 6. Abnormal test signal.
 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
- G. A $\frac{3}{4}$ inch conduit with the required conductors shall be extended from the dialer to the nearest telephone terminal board. The telephone company shall provide and install interface terminal block. Electrical Contractor shall terminate conductors on one side of this terminal block as directed by the telephone company. The Owner shall contract with the telephone company for a private line for the dialer.

2.14 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
1. Factory fabricated and furnished by manufacturer of device.
 2. Finish: Paint of color to match the protected device.

2.15 SURGE SUPPRESSION

- A. Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel and transmitter components. Mount suppressors in separate enclosure(s) adjacent to control panel and transmitter unless suppressors are specifically UL listed or FM approved for mounting inside the control panel and transmitter provided and approved for such use by the control panel and transmitter manufacturer.
1. Line Voltage Surge Suppressor: Suppressor shall be UL 1449 listed with a maximum 330 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor shall also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. Suppressor shall be a multi-stage construction which includes inductors and silicon avalanche zener diodes. Suppressor shall have a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components. Fuses shall be externally accessible. Wire in series with the incoming power source to the protected equipment using screw terminations.
 2. Low Voltage Surge Suppressor: Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two or more buildings, provide an arrester at the circuit entrance to each building. Suppressor shall be UL 497B listed with a maximum 30 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor shall have multi-stage construction and both differential/common mode protection.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, the plan drawings, specifications, manufacturer's recommendations, and all applicable codes for installation of fire-alarm equipment. All wiring shall be installed in compliance with NFPA 70, *National Electrical Code*[®].
- B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than 72 inches above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
1. 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.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.
1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 2. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
1. Connect new equipment to existing control panel in existing part of the building.
 2. Connect new equipment to existing monitoring equipment at the supervising station.
 3. Expand, modify, and supplement existing control monitoring equipment as necessary to extend existing control monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- E. Smoke- or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

- K. Manual Pull Stations: Locate manual pull stations where shown on the drawings. Provide recessed back boxes in which the station operating mechanisms shall be mounted.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Alarm-initiating connection to elevator recall system and components.
 - 3. Alarm-initiating connection to activate emergency lighting control.
 - 4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Supervisory connections at elevator shunt trip breaker.

3.3 FIELD WIRING

- A. Wire Nuts are not permitted. Multiple wires on a single terminal are prohibited.
- B. Signaling Line circuits, initiating device circuits, and notification appliance circuits shall be supervised in accordance with the requirements of NFPA 72.
- C. Provide wiring within cabinets installed parallel with or at right angles to the sides and back of the enclosure. All conductors which are terminated, spliced, or otherwise interrupted in any enclosure associated with the fire alarm system shall be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with either crimp-on terminal spade lugs or with pressure type terminal blocks.
- D. Provide a terminal cabinet where any circuit tap is made.
- E. For alarm and supervisory initiating device circuit and alarm indicating circuit wiring for the low voltage portion of the fire alarm system, provide all wiring as recommended by the equipment manufacturer. Provide wiring operating at 120 VAC as minimum No. 12 AWG solid copper having similar insulation.
- F. Conductors shall be run in metal raceway including EMT and rigid conduit.
- G. Signaling Line Circuits, Initiating Device Circuits and Notification Appliance Circuits:

1. Power-Limited Circuits: For interior wiring (in raceways) use power-limited insulated multiconductor cable types except where a 2-hour fire rated cable assembly is required.
 - a. Number of conductors and conductor size as recommended by the Company producing the system, except that conductor size shall not be less than No. 18 AWG for signaling line circuits and not less than No. 16 AWG for initiating device circuits and notification appliance circuits.
 - b. Using Non-power-Limited Wiring On Power-Limited Circuits: Wiring size and types specified for NONPOWER-limited circuits may be used for power-limited circuits if power-limited circuits are reclassified and the power-limited markings are eliminated. Refer to NEC Article 760-52(a) Exception No. 3.
- H. Distinctively color code all wiring differently from the normal building wiring. Audible alarm indicating devices shall be color coded differently from alarm initiating circuits. Use different colors for visual alarm indicating devices.
- I. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system or elevator system, the addressable fire alarm interface module shall be within 10 feet of the emergency control device.
- J. Provide a terminal cabinet where any circuit tap is made.
- K. Provide wiring within cabinets installed parallel with or at right angles to the sides and back of the enclosure. All conductors which are terminated, spliced, or otherwise interrupted in any enclosure associated with the fire alarm system shall be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with either crimp-on terminal spade lugs or with pressure type terminal blocks.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- C. Install framed instructions in a location visible from fire-alarm control unit.
- D. Provide fire alarm circuit conductors with color coded insulation or use color coded tape at each conductor termination and in each junction box and interface panel.
- E. Distinctively color code all wiring differently from the normal building wiring. Audible alarm notification appliance circuits shall be colored differently from signaling line circuits. Use different colors for visual alarm notification appliance circuits.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2. Following are the specific requirements for intelligibility tests:
 - a. Intelligibility Requirements: Verify intelligibility by measurement after installation.
 - b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is 0.8.
 - c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.
 - d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.
 - e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).
 - f. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:
 - 1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

- 2) Curving around any corners or obstructions, with a 12 inches clearance there from.
 - 3) Terminating directly below the location where the minimum required CIS value has been obtained.
- g. Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.
- 4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72. After final testing is complete provide a letter certifying that the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests. An authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
 - 7. Audibility tests shall be performed to verify compliance with the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG). If the system does not meet the intended performance of the ADAAG, the fire alarm system distributor shall provide additional speakers and system expansion parts to accommodate them, as required to meet the required audibility levels.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.
 - H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the Owner. All training sessions shall be conducted following final system certification. All training sessions shall be conducted by an authorized fire alarm system distributor representative.

- B. Provide training sessions (minimum of three) for all security personnel on all shifts designated by the Owner.
- C. Comprehensive system troubleshooting training shall be provided for a single individual designated by the Owner. This session shall be separate and distinct from the above described sessions.

3.8 SERVICE AGREEMENT

- A. Included in the bid price shall be a one year service contract, effective upon final system acceptance, to provide all service required beyond the capability of the facility personnel. Contract shall include all service and repairs required and annual system testing and inspection in accordance with NFPA 72.

3.9 WARRANTY

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

END OF SECTION 28 31 11

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing existing vegetation.
2. Clearing and grubbing (if needed).
3. Stripping and stockpiling topsoil (if needed).
4. Removing above- and below-grade site improvements.
5. Disconnecting, capping or sealing, removing site utilities, and abandoning site utilities in place.
6. Temporary erosion- and sedimentation-control measures.

1.2 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated on plans.
- F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 SUBMITTALS

- A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at the Project site.

1.6 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 Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify "North Carolina OneCall (811)" for area where Project is located before site clearing.
- C. The Contractor shall be responsible for locating underground utilities prior to commencing work and / or excavation. If necessary, the construction manager may obtain the services of a commercial utilities locator and/or various utility companies who may have lines inside the area. In addition, Contractors shall contact the Owner's Representative at least five days prior to excavation. The Contractor will be responsible for utility interruptions caused by construction operations including excavations
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place and erosion control permit is obtained and posted at job-site.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on- site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Install temporary construction fencing per Section 01 "Temporary Facilities and Controls".
- C. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.
- D. 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 erosion- and sedimentation-control Drawings and requirements of NC State University and NCDEQ.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Coordinate with Owner prior to shutting off any utilities.
 - 2. Arrange with utility companies to shut off indicated utilities.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner, and Engineer not less than (72) hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 3. Chip removed tree branches and dispose of off-site.
- 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.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to a minimum depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 - 3. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement and concrete to remain before removing adjacent existing pavement or concrete. Saw-cut faces vertically.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. 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.
- B. 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. Do not interfere with other Project work.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. North Carolina Department of Transportation and NC State Design and Construction Guideline Standard Specifications and Details where applicable.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
2. Excavating and backfilling for structures.
3. Subbase course for concrete walks and pavements.
4. Subbase course and base course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 31 Section "Site Clearing" for site stripping, grubbing, stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Division 31 Section "Erosion and Sedimentation Control".
5. Division 33 Section "Storm Utility Drainage Piping".

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices and quantity allowances for earth moving specified in Division 01 Section "Unit Prices".
- B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials for that condition.
 1. 24 inches outside of concrete forms other than at footings.
 2. 12 inches outside of concrete forms at footings.
 3. 6 inches outside of minimum required dimensions of concrete cast against grade.
 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 5. 6 inches beneath bottom of concrete slabs-on-grade.
 6. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Design Subgrade: Final subgrade elevation shown on site grading plan.
- F. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below design subgrade elevations or beyond indicated lines and dimensions as directed by Engineer or Owner's Testing Agency. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 3. Unauthorized Excavation: Excavation below design subgrade elevations or beyond indicated lines and dimensions without direction by Engineer or Owner's Testing Agency. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted Caterpillar 330 (or equivalent) using new rock teeth.
 2. Bulk Excavation: Late-model, Caterpillar D-8 (or equivalent) pulling a single-tooth ripper.
- 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. Structural Fill: Soil free of trash, refuse, frozen material, or other deleterious materials, and contains less than 3% organics. Shall be free of rock or gravel larger than allowed for fill or backfill material as specified hereinafter or as shown on the drawings.
- L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:

1. Geosynthetics.
 2. Lime and/or cement utilized for soil/base modification.
 3. ABC stone
 4. Detector warning tapes.
- B. Material Test Reports: For each off-site soil material proposed for fill and backfill as follows:
5. Classification according to ASTM D 2487 or method approved by Owner Representative.
 6. Laboratory compaction curve according to ASTM D 698 or method approved by Owner Representative.
- C. Blasting plan approved by authorities having jurisdiction and only if Owner pre-approves of blasting.
- D. Seismic survey report from seismic survey agency.
- E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

- A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 2. Seismographic monitoring during blasting operations.
- B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 2. Seismographic monitoring during blasting operations.
- C. Owner's Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- D. Pre-excavation Conference: Conduct conference at the Project Site prior to commencement of site grading.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
1. Do not close or obstruct streets, parking lots, access drives, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Owner.
- C. Utility Locator Service: Notify "North Carolina OneCall (811)" for area where Project is located before beginning earth moving operations.
- D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Sections "Site Clearing" and "Erosion and Sedimentation Control" are in place.
- E. Do not commence earth moving operations until a Town of Wendell Permit and NCDEMLR Erosion Control Plan Letter of Approval are obtained and posted at the project site.
- F. Do not commence earth moving operations until plant-protection measures shown on the Construction Drawings are in place.
- G. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- H. Do not direct vehicle or equipment exhaust towards protection zones.
- I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

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: Unified Soil Classification System (USCS) Groups SM, SC, SW, SP, ML, and CL according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, greater than 3% organic material, and other deleterious matter; have a standard Proctor maximum dry density of at least 90 pounds per cubic foot (pcf). USCS groups CH and MH found at the project site can be used, provided the moisture content can be controlled, but should not be placed within 2 feet of final subgrade elevations.
 1. Compact to not less than 95% of the standard Proctor maximum below 12" and not less than 98% of the standard Proctor maximum for the last 12".
- C. Unsatisfactory (or Unsuitable) Soils: Soils not meeting Satisfactory Soils as described in 2.1.B.
 1. On-site borrow materials with natural moisture contents at time of excavation below or up to 10 percent wet of the soil's optimum moisture content shall not be classified as unsatisfactory if the material otherwise meets the material requirements for satisfactory materials. The contractor shall wet or dry these materials to the acceptable moisture range, chemical dry, or replace with off-site borrow at no additional cost to the Owner

2. On-site borrow materials with moisture contents more than 10 percent wet of the soil's optimum moisture content may be considered unsatisfactory. If unsatisfactory soils are found, a meeting with owner and owners testing agency will be required prior to hauling off material.
 3. Additional materials deemed unsatisfactory or unsuitable by Owner's Representative.
- D. Base Course: Aggregate meeting the ABC stone requirements specified in section 1005-3 and 1005-4 of the North Carolina Department of Transportation Standard Specifications for Roads and Structures, Current Edition.
 - E. 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.
 - F. Structural Fill: Same as Satisfactory Soils.
 - 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.
 - K. Topsoil: Due to previous project work on campus, there is a current stockpile of topsoil onsite. Based on recommendations from the current Project Representatives onsite it is believed that the topsoil needed for this project is stockpiled onsite.

2.2 GEOTEXTILES

- A. Subsurface Drainage / Separation Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Grab Tensile Strength: 205 lb; ASTM D 4632.
 2. Grab Tensile Elongation: 50%; ASTM D 4632.
 3. Trapezoidal Tear Strength: 80 lb; ASTM D 4533.
 4. CBR Puncture Strength: 500 lb; ASTM D 6241.
 5. Apparent Opening Size: No. 80 sieve, maximum; ASTM D 4751.
 6. Permittivity: 0.2 per second, minimum; ASTM D 4491.
 7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Stabilization Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 2. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 3. Tear Strength: 90 lbf; ASTM D 4533.

4. Puncture Strength: 90 lbf; ASTM D 4833.
5. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
6. Permittivity: 0.02 per second, minimum; ASTM D 4491.
7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Identification of underground utilities shall be provided per the latest version of NC State Design and Construction Guidelines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Follow Construction Sequence provided on Drawings.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- C. Protect and maintain erosion and sedimentation controls during earth moving operations.
- D. Remove from site, material encountered in grading operations that does not meet the definition of Satisfactory Soils (2.1.B). Dispose of in manner satisfactory to Owner and local governing agencies. Backfill areas with layers of satisfactory material and compact as specified herein. Materials encountered within the top 6 inches of existing site elevations (prior to stripping) are the responsibility of the Contractor at no additional cost to the Owner (i.e. allowances only apply to depths below top 6 inches of existing site elevations, prior to stripping).
- E. Prior to placing fill in low areas, such as previously existing creeks, or ponds, perform following procedures:
 1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain the same results.
 2. After drainage of low area is complete, remove muck, mud, debris, and other unsatisfactory material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed. Materials encountered within the top 6 inches of existing site elevations (prior to stripping) are the responsibility of the Contractor at no additional cost to the Owner (i.e. allowances only apply to depths below top 6 inches of existing site elevations, prior to stripping).
 3. All muck, mud, and other materials removed from low areas shall be dried on-site by spreading in thin layers for observation. Material shall be inspected and, if found to be satisfactory for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not within 5'-0" of perimeter of paving or retaining wall subgrade. If, after observation, material is found to be unsatisfactory, it shall be removed from site.
- F. After topsoil stripping, notify Owner's Testing Agency. Proof-roll exposed subgrades in fill areas with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or frozen subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer or Owner's Testing Agency, and replace with compacted backfill or fill as directed. Materials encountered within the top 6 inches of existing site elevations (prior to stripping) are the responsibility of the Contractor at no additional cost to the Owner (i.e. allowances only apply to depths below top 6 inches of existing site elevations, prior to stripping).
- G. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.
- 3.2 DEWATERING
- A. Design:
1. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
 2. Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.
 3. Contractor shall be responsible for the design, installation, operation, maintenance, and any failure of any component of the system.
- B. Damages:
1. Contractor shall be responsible for an shall repair any damage to work in place, other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation. Contractor responsibility shall also include, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.
 2. Remove subgrade materials rendered unsatisfactory by excessive wetting and replace with approved backfill material at no additional cost to the Owner.
- C. Maintaining Excavation in Dewatering Condition
1. Dewatering shall be a continuous operation. Interruptions due to power outages or any other reason will be permitted.
 2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
 3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the vent any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner.
 4. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components and any other work required to maintain excavation in dewatered condition.
- D. System Removal: Upon completion of the work, remove dewatering equipment from the site, including related temporary electrical service.

- E. Wells shall be removed or cut off a minimum of 3 feet below final ground surface, capped and abandoned in accordance with regulations by agencies having jurisdiction.

3.3 EXPLOSIVES

- A. Explosives: Obtain written permission from authorities having jurisdiction including Owner before bringing explosives to Project site or using explosives on Project site.
 - 1. Perform blasting without damaging adjacent structures, property, or site improvements.
 - 2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to design subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include pavements, underground structures, utilities, obstructions, and other items indicated to be removed; together with soil, boulders, and rock. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or unsuitable soils to subgrade elevation.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory materials. Contractor will be paid for disposal and replacement of unsatisfactory materials encountered at depths greater than 6 inches below the existing ground surface elevation, prior to stripping.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - b. 24 inches outside of concrete forms other than at footings. 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 subbase materials.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.
- B. Unsatisfactory Soils: Volume of soils not meeting the definition of Satisfactory Soils (2.1.B), or determined by the Owner's Testing Agency to be unstable or unsuitable for subgrade support, measured in original position, and replaced with satisfactory structural fill/subgrade/foundation material that meets the allowable design bearing pressure, compaction requirements, and settlement limitations specified in the geotechnical report and construction documents for the site and structure. Unsatisfactory soils shall not be removed until approved and cross-sectioned by Owner's Testing Agency. Changes in the Contract Sum or the Contract Time will be in accordance with Allowances and Unit Prices provisions for removal and replacement of unsuitable soils. No changes in the Contract Sum or the Contract Time if unsatisfactory materials are encountered within 6 inches below the existing ground surface elevation, prior to stripping.

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. Deep Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before deep foundations are placed. After foundations have been installed, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete caps.
 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

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. Excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.
1. Clearance: 6 inches each side of pipe or conduit.
- 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, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or unsuitable soils to trench bottom.
- E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.8 SUBGRADE EVALUATION

- A. Notify Owner's Testing Agency when excavations have reached required subgrade.
- B. If Owner's Testing Agency determines that Unsatisfactory Soils (3.4.B) are present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll final subgrade below pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or frozen subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer or Owner's Testing Agency, and replace with compacted backfill or fill as directed.
- D. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or Unsatisfactory soils to subgrade elevation.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavations as directed by Engineer.

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.
 2. Place silt fence approximately 3-ft from edge of stockpile.
 3. 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.
 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. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil.

D. Trenches under Roadways: After installing and testing piping or conduit less than 30 inches below surface of roadways, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil compacted in accordance with specifications provided herein while removing shoring and bracing.

F. Place and compact initial backfill of subbase material and satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

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

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. All underground piping and utilities (both metallic and non-metallic), except lawn irrigation lines, shall have two stages of identification and/or warning by a combination of non-detectable and detectable warning tapes.

I. Install warning tape (detectable warning tape) directly on top of the pipeline and permanently secured to the pipeline at 10' intervals.

J. Install identification tape (non-detectable warning tape) approximately 18" to 30" above the service pipe, but a minimum of 10" and a maximum of 24" below finished grade.

K. Install tracer wire to bottom of pipe taped at a maximum of 10' intervals. An insulated copper tracer wire or other approved conductor shall be installed along the length of the pipe to all nonmetallic piping, including irrigation lines, and metallic pipe with compression gasket fittings installed underground. Access shall be provided to the tracer wire or the tracer wire shall terminate aboveground at the end of the nonmetallic piping. The tracer wire size shall be copper single-conductor 10AWG minimum and the insulation type suitable for direct burial with type "UF" (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box or manhole.

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 using satisfactory fill (or structural fill) to required elevations.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

- 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 95 percent of maximum dry unit weight according to ASTM D 698 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 one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 95 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
 - 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.18 BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place base course on subgrades approved by the Owner's Testing Agency free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
 - 1. Place base course material over subgrade under hot-mix asphalt pavement.
 - 2. Shape base course to required crown elevations and cross-slope grades.
 - 3. Place base course 10 inches or less in compacted thickness in a single layer.
 - 4. Place base course that exceeds 10 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 4 inches thick.
 - 5. Compact base course at moisture content within +/- 2% of optimum moisture to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D1556 as modified by NCDOT.
- C. Pavement Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each base layer to not less than 98 percent of maximum dry unit weight according to the standard Proctor maximum dry density (ASTM D698).

3.19 FIELD QUALITY CONTROL

- A. Owner's Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to evaluate and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- 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 Engineer.

- 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: At subgrade and at each compacted fill and backfill layer, at least one test for every 2500 sq. ft. or less of paved area, but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- 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 materials to depth required; recompact and retest until specified compaction is obtained.

3.20 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 Engineer; reshape and recompact.
- 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.
- D. Maintain subgrades to receive base course stone within compaction and moisture requirements continuously until stone is placed.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil and topsoil to designated storage areas on Owner's property or remove from site and legally dispose as directed by Engineer. Stockpile or spread soil as directed by Engineer.
1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 23 17 – TRENCHING

PART 1 - GENERAL

1.1 GENERAL NOTES

- A. Prior to beginning Work, Contractor to request a field inspection with the Owner and Engineer for inspection before project start and before project acceptance.
- B. Trenches for underground piping, where necessary shall be excavated to the required depth and bell holes shall be provided where necessary to insure uniform bearing. Trench excavation lines shall provide sufficient clearance for proper execution of underground work.
- C. Trenches shall be open cut from the surface. Irregularities at bottom of trench, or where excavation is below required depth shall be refilled to required grade with compacted soil, or flowable fill at direction of onsite geotechnical engineer.
- D. The Contractor shall be held responsible for the sufficiency of sheeting and bracing and for all damages to property or injury to persons resulting from improper quality, strength, placing and maintenance of trench shoring, sheeting or bracing.
- E. Existing utility lines to be retained that are shown on construction drawings or locations of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation and backfilling, and if damaged shall be repaired by Contractor, at own expense.
- F. Existing utility lines found during excavations that were not shown on construction drawings or made known to Contractor prior to excavation shall be protected and remain uninterrupted until approval by Owner or Engineer to proceed.
- G. The Contractor shall be responsible for providing and maintaining a pedestrian and traffic control plan in accordance with Owner standards.
- H. All underground utilities encountered during the projects construction shall be located by a Professional Land Surveyor licensed in North Carolina.

1.2 DEFINITIONS

- A. Standard Specifications: When referenced in this section, shall mean Department of Transportation Standard Specifications For Roads And Structures (Latest Version). Parts of these Standard Specifications that are specifically referenced shall become part of this section as though stated herein in full. In case of a discrepancy between the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 SUMMARY

- A. Section Includes:
 - 1. Excavating trenches for utilities from 5 feet outside any building to terminating connection.
 - 2. Compacted fill from top of utility bedding to finished grade.
 - 3. Backfilling and compaction.

1.4 SUBMITTALS

- A. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

B. Product Data: Geotextile fabric indicating fabric and construction.

C. Materials Source: Name of imported fill materials suppliers.

1.5 QUALITY ASSURANCE

A. Use this Article to specify compliance with overall reference standards affecting products and installation.

B. Perform Work according to NCDOT, City of Raleigh, and NC State standards.

C. Prepare excavation protection plan under direct supervision of professional engineer experienced in design of this Work and licensed in State of North Carolina.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type as specified in Standard Specifications.

B. Structural Fill: Type as specified in Standard Specifications.

C. Granular Fill: Type as specified in Standard Specifications.

D. Concrete:

1. Lean concrete.

2.2 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, non-woven. Use NCDOT standard for fabric application and type by use.

PART 3 - EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated.

1. Engineer may make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Call local utility line information service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect benchmarks, existing structures, trees, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

- A. Excavate subsoil required for utilities.
- B. Remove lumped subsoil, boulders, and rock over 6 inches.
- C. Perform excavation within 24 inches of existing utility service according to utility's requirements.
- D. Do not advance open trench more than 200 feet ahead of installed pipe.
- E. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work, dewater in accordance with Section 31 23 19.
- F. Excavate bottom of trenches to a maximum of 2 feet past outside diameter dimensions or outside of concrete cradle.
- G. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.
- H. When Project conditions permit, slope side walls of excavation starting 24 inches above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this Section.
- I. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by onsite Owner's Testing Agency until suitable material is encountered.
- J. Cut out soft areas of subgrade not capable of compaction in place. Backfill with flowable fill or Owner's Testing Agency approved fill and compact to density equal to or greater than requirements for subsequent backfill material.
- K. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- L. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.
- M. Remove excess subsoil not intended for reuse, from Site.
- N. Stockpile excavated material in area designated on Site according to Section 31 25 00.

3.4 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. Support trenches excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation or at direction of onsite geotechnical engineer.
- C. Design sheeting and shoring to be removed at completion of excavation Work.
- D. Repair damage caused by failure of sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

- A. Backfill trenches to contours and elevations with Satisfactory Soils per Section 312000.

- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- C. Place fill material in continuous layers and compact to 95 percent of the material's standard Proctor maximum dry density ASTM D698), except in the top 12 inches where this shall be increased to 98 percent.
- D. Protect open trench to protect the public.

3.6 FIELD QUALITY CONTROL

- A. Perform laboratory material tests according to ASTM D698.
- B. Perform in place compaction tests according to following:
 - 1. Density Tests: ASTM D698.
 - 2. Moisture Tests: ASTM D3017.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.
- D. Test as required in Section 31200, "Field Quality Control".

3.7 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION 31 23 17

SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 GENERAL NOTES

- A. Excavations should be kept dry at all times by means of cofferdams, trenches, sumps, pumps or other equipment or arrangements required and approved.
- B. Prevent surface water from flowing into excavations, ponding on prepared subgrades and from flooding Project site and surroundings.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation and/or subsurface seepage.
- D. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations or trenches. Establish and maintain temporary drainage ditches and other diversions outside excavation limits as required and approved by Owner or Engineer.
- E. Do not use excavations or trenches as temporary drainage ditches.

1.2 SUMMARY

- A. Section Includes:
 - 1. Construction site dewatering.

1.3 DEFINITIONS

- A. Dewatering includes the following:
 - 1. Removing surface or ground water from within excavations or trenches.
 - 2. Disposing of removed water.
- B. Surface Water Control: Removal of surface water within open excavations.

1.4 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
 - 1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 5. Remove dewatering system when no longer required for construction.

1.5 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to dewatering including, but not limited to, the following:
 - a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.

- b. Proposed site clearing and excavations.

1.6 PROJECT CONDITIONS

- A. Survey Work: Engage a qualified land surveyor to survey adjacent structures and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if any damage is evident in adjacent construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION

- A. Conduct additional borings and investigations to supplement subsurface investigations identified as required to complete dewatering system design.
- B. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Monitor dewatering systems continuously.
- E. Promptly repair damages to adjacent facilities caused by dewatering.
- F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 31 25 00 during dewatering operations.

3.3 INSTALLATION

- A. Contractor shall furnish, install, operate, and maintain any pumping equipment, etc. needed for removal of water from various parts of the site at no additional cost to the Owner.
- B. Work shall be in accordance with NCDOT standards.

3.4 FIELD QUALITY CONTROL

- A. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION 31 23 19

SECTION 31 23 24 - FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Flowable fill for:
 - a. Structure backfill.
 - b. Utility bedding.
 - c. Utility backfill.
 - d. Filling abandoned utilities.
 - e. Concrete Cradle.

1.2 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.
- B. Excavatable Flowable Fill: Lean cement concrete fill used where future excavation may be required such as fill for utility trenches, bridge abutments, and culverts.
- C. Non-excavatable Flowable Fill: Lean cement concrete fill used where future excavation is not anticipated such as fill below structure foundations and filling abandoned utilities.

1.3 SUBMITTALS

- A. Materials Source: Name of flowable fill materials suppliers.
- B. Mix Design:
 - 1. Furnish flowable fill mix design for each specified strength. Furnish separate mix designs when admixtures are require for following:
 - a. Flowable fill Work during hot and cold weather.
 - b. Air entrained flowable fill Work.
 - 2. Identify design mix ingredients, proportions, properties, admixtures, and tests.
 - 3. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.
- C. Delivery Tickets:
 - 1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.4 QUALITY ASSURANCE

- A. Perform Work according to State of North Carolina Department of Transportation standards.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.
 - 1. Product source approved by authority having jurisdiction.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not install flowable fill during inclement weather or when ambient temperature is less than 40 degrees F.

PART 2 - PRODUCTS

2.1 FLOWABLE FILL

- A. Furnish materials according to State of North Carolina Department of Transportation standards.
- B. Flowable Fill: Excavatable type.

C. Flowable Fill for Stormwater Control Measure cradle: Non-Excavatable Type; 750 psi minimum.

2.2 MATERIALS

A. Portland Cement: ASTM C150 Type I - Normal.

B. Fine Aggregates: ASTM C33.

C. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES

A. Furnish materials according to State of North Carolina Department of Transportation standards.

2.4 MIXES

A. Mix and deliver flowable fill according to ASTM C94/C94M, Option C.

B. Flowable Fill Design Mix:

ITEM	EXCAVATABLE	NON-EXCAVATABLE
Cement Content	75 to 100 lb/cu yd	100 to 150 lb/cu yd
Fly Ash Content	None	150 to 600 pcf
Water Content	As specified	As specified
Air Entrainment	5-35 percent	5-15 percent
28-Day Compressive Strength	Maximum 100 psi	Minimum 125 psi
Unit Mass (Wet)	80 to 110 pcf	100 to 125 pcf
Temperature, Minimum at Point of Delivery	50 degrees F	50 degrees F

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 SOURCE QUALITY CONTROL

A. Test and analyze properties of flowable fill design mix and certify results for following:

1. Properties of hardened flowable fill design mix including:

- a. Compressive strength at 1 day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.
- b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

B. Prepare delivery tickets containing following information:

1. Project designation.
2. Date.
3. Time.
4. Class and quantity of flowable fill.
5. Actual batch proportions.
6. Free moisture content of aggregate.
7. Quantity of water withheld.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavation is complete.
- B. Verify utility installation is complete and tested before placing flowable fill.
- C. Verify excavation is dry and dewatering system is operating, if required.

3.2 PREPARATION

- A. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.
- B. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.
- C. Protect utilities to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL

- A. Place flowable fill by chute, pumping or other methods approved by Engineer.
 - 1. When required, place flowable fill under water using tremie procedure.
 - 2. Do not place flowable fill through flowing water.
- B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.
- C. Place flowable fill evenly on both sides of utilities to maintain alignment.
- D. Place flowable fill to elevations indicated without vibration or other means of compaction.

3.4 INSTALLATION - FILLING ABANDONED UTILITIES

- A. Perform work in accordance with Standard Specifications and Construction Drawings.
- B. Verify pipes and conduits are not clogged and are sufficiently empty to permit gravity installation of flowable fill for entire length indicated to be filled.
- C. Seal lower end of pipes and conduits by method to contain flowable fill and to vent trapped air caused by filling operations.
- D. Place flowable fill using method to ensure there are no voids.
 - 1. Fill pipes and conduits from high end.
 - 2. Fill manholes, tanks, and other structures from grade level access points.
- E. After filling pipes and conduits seal both ends.

3.5 FIELD QUALITY CONTROL

- A. Perform testing according to ASTM C94/C94M.
 - 1. Take samples for tests for every 150 cu yd of flowable fill, or fraction thereof, installed each day.
 - 2. Sample, prepare and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.
 - 3. Measure temperature at point of delivery when samples are prepared.
- B. Defective Flowable Fill: Fill failing to meet following test requirements or fill delivered without following documentation.
 - 1. Test Requirements:
 - a. Minimum temperature at point of delivery.
 - b. Compressive strength requirements for each type of fill.
 - 2. Documentation: Duplicate delivery tickets.

3.6 CLEANING

- A. Remove spilled and excess flowable fill from Project Site.
- B. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION 31 23 24

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers work necessary for stabilization of soil to prevent erosion during and after construction and land disturbance activities. The work shall include furnishing all labor, materials, tools, and equipment to perform all work and services necessary for or incidental to the furnishing and installation, complete, of all operations in connection with erosion control as shown on drawings and as specified, in accordance with provisions of the Contract Documents, and completely coordinated with work of all other trades. The Contractor shall insure that all sedimentation features are in place prior to construction as necessary. Contractor shall remove the features as ground cover is established with approval of the Engineer and/or controlling authorities.
- B. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. The right is reserved to modify the use, location, and quantities of soil erosion and sedimentation control measures based on activities of the Contractor and as the Engineer considers to be the best interest of the Owner.
- C. Any governmental agency standard as noted below should be referenced as the latest, most recent, or current version of the referenced standard.
- D. The Contractor shall implement the approved Erosion and Sediment Control plan and follow all state requirements regarding sedimentation and erosion control. Construction methods shall minimize sedimentation and erosion.
- E. See additional information noted on the Drawings.

1.2 DEFINITIONS

- A. NCDOT: North Carolina Department of Transportation
- B. NCDEQ - DEMLR: North Carolina Department of Environmental Quality - Division of Energy, Mineral, and Land Resources.
- C. Standard Erosion Control Specification: North Carolina Erosion and Sediment Control Planning and Design Manual, latest version. Available at the following location:
<http://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>

1.3 GENERAL

- A. All activities shall conform to the Standard Erosion Control Specification: North Carolina Erosion and Sediment Control Planning and Design Manual, latest version; the approved erosion control permit; the Specifications; and the Drawings. In the event of a conflict, the more stringent requirement shall apply.
- B. The Sections of the Standard Erosion Control Specifications referenced include, but are not limited to:

Standard & Specification No	Title
6.06	Temporary Gravel Construction Entrance / Exit
6.10	Temporary Seeding

6.17	Rolled Erosion Control Products
6.20	Temporary Diversions
6.32	Temporary Slope Drains
6.51	Hardware Cloth and Gravel Inlet Protection
6.62	Sediment Fence (Silt Fence)
6.64	Skimmer Sediment Basin
6.66	Compost Sock
6.80	Construction Road Stabilization
6.83	Check Dam

- C. Soil erosion stabilization and sedimentation control shall consist of the following elements:
1. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
 2. Construction of temporary erosion control facilities such as silt fences, inlet protection, etc.
 3. Topsoil, Temporary Seeding, and Sod:
 - a. Placement and maintenance of Temporary Seeding on all areas disturbed by construction, as necessary.
 - b. Placement of permanent topsoil, fertilizer, and sod, etc. in areas as specified on the Drawings.
 4. It is the intent that all areas in which construction activities have disturbed existing vegetation shall be temporarily seeded, as required, top soiled, and permanently sodded.
- D. The Contractor shall be responsible for phasing Work in areas allocated for his / her exclusive use during this Project, including any proposed stockpile areas, to restrict sediment transport. This will include installation of any temporary erosion control devices, ditches, or other facilities that may be required to comply with NCDEQ regulations and requirements.
- E. The areas set aside for the Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his / her exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be done in a manner to both control all sediment transport from the project area, and to permit the area to be returned to design grades and drainage patterns upon completion of the project.
- F. Upon completion of the Project, all areas that have been disturbed by the Contractor shall be stabilized by top-soiling and permanent sodding seeding as shown on the Drawings.
- G. All permanent stockpiles, if any, shall be seeded with soil stabilization seed and protected by construction of two (2) rows of silt fence.
- H. Sediment transport and erosion from working stockpiles shall be controlled and restricted from moving beyond the immediate stockpile area by construction of temporary silt fence, as

necessary. The Contractor shall keep these temporary facilities in operational condition by regular cleaning, re-grading, and maintenance.

- I. The Contractor shall maintain all elements of the Soil Erosion Stabilization and Sedimentation Control systems to be constructed during this Project for the duration of his / her activities on this Project. Formal inspections made jointly by the Contractor and the Engineer shall be conducted every week to evaluate the Contractor's conformance to the requirements of both these Specifications and NCDEQ regulations.
- J. Maintenance of the Soil Erosion Stabilization and Sedimentation Control systems constructed as part of this project shall be in accordance with the Drawings and NCDEQ Standard Erosion Control Specifications.
- K. Contractor shall remove all erosion control measures from the site once permit requirements for vegetation establishment have been met. All areas disturbed during the removal of erosion control measures shall be raked, stabilized, and planted per the Drawings.

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the Specifications, Section 013300, "Submittal Procedures."
- B. In addition, the Contractor shall provide the following specific information:
 - 1. If Contractor plans to vary erosion control phasing from the Drawings, then he / she shall submit a written plan, including definition and locations of phased erosion and sediment control for areas that will be disturbed during staged construction sequences. This information shall be provided to the Engineer and Owner, for review, before commencing any Work on the Project.

1.5 QUALITY ASSURANCE

- A. Perform Work according to NCDEQ-DEMLR standards.

1.6 INSPECTIONS AND RECORD KEEPING

- A. The Contractor is responsible for self-inspection of sedimentation and erosion control devices throughout the life of the Work, including preparation of self-inspection reports and NPDES Self-Monitoring Reports, to make sure the approved erosion and sedimentation control plan is being followed. To simplify documentation of Self-Inspection Reports and NPDES Self-Monitoring Reports, Contractor shall use a combined form available at <http://deq.nc.gov/about/divisions/energy-mineral-land-resources/erosion-sediment-control/forms>
- B. Contractor shall refer to Self-Inspection Reports Reporting Requirements on Drawings.

PART 2 - PRODUCTS

2.1 AGGREGATE

- A. Temporary Construction Entrance
 - 1. Furnish according to Standard Erosion Control Specification
- B. Silt Fence Outlet
 - 1. Furnish according to Standard Erosion Control Specification

2.2 GEOTEXTILES

- A. Sediment Fence Geotextile
 - 1. Furnish according to Standard Erosion Control Specification

- B. Construction Entrance Geotextile
 - 1. Furnish according to Standard Erosion Control Specification
- C. Rolled Erosion Control Blanket
 - 1. Rolled erosion control blankets shall have a minimum allowable shear stress of 1.5-lbs/ft² and a minimum longevity of 12 months
 - 2. Anchoring devices for rolled erosion control blankets shall be minimum 11 gauge staples, 1-in wide, and 6-in long or 12-in minimum length wooden stakes.
- 2.3 TEMPORARY SLOPE DRAINS
 - A. Furnish according to Standard Erosion Control Specification
- 2.4 SKIMMER BASIN
 - A. Skimmer shall meet the design requirements of the drawings and the Standard Erosion Control Specifications
 - B. Porous baffles shall be furnished according to Standard Erosion Control Specification
- 2.5 SEDIMENT FENCE STEEL POSTS
 - A. Furnish according to Standard Erosion Control Specification
- 2.6 SEDIMENT FENCE FABRIC REINFORCEMENT
 - A. Furnish according to Standard Erosion Control Specification
- 2.7 COIR FIBER WATTLE
 - A. Coir Fiber Wattle shall meet the following specifications:
 - 1. 100% Coir (Coconut) Fibers
 - 2. Minimum Diameter 12 in.
 - 3. Minimum Density 3.5 lb/ft³ +/- 10%
 - 4. Net Material Coir Fiber
 - 5. Net Openings 2 in. x 2 in.
 - 6. Net Strength 90 lbs.
 - 7. Minimum Weight 2.6 lbs./ft. +/- 10%
- 2.8 PLANTING MATERIALS
 - A. Temporary Seeding and Soil Supplements:
 - 1. Furnish according to Standard Erosion Control Specification
 - B. Permanent Seeding (if used)
 - 1. Furnish according to Standard Erosion Control Specification
 - C. Sod (if used)
 - 1. Furnish according to Owner requirements matching the existing natural turf within the project area.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install erosion and sediment control measures and maintain in accordance with the Drawings, the sequence of construction shown on the Drawings are made a part of these Contract Documents.

- B. The Contractor shall install any additional measures which the Engineer or Inspector may deem necessary to comply with the Standard Erosion Control Specification general criteria or NCDEQ Erosion Control requirements, at no additional cost to the Owner.
- C. The Contractor shall provide and maintain Temporary Seeding at all times.

3.2 SILT FENCE

- A. Silt fence to be installed as indicated on Drawings and per the Standard Erosion Control Specification. Silt fence to be placed prior to demolition, trench installations, or other clearing activities. Silt fence may be temporarily removed and replaced to facilitate construction.
- B. Maintenance shall be performed per the Standard Erosion Control Specification.
- C. After ground cover has been established and approved by Engineer and NCDEQ Erosion Control Inspector, the silt fence shall be removed and disposed of in an approved off-site location at the Contractor's expense.

3.3 SILT FENCE OUTLETS

- A. Install silt fence outlets per the details shown on Drawings and per the Standard Erosion Control Specification.
- B. Maintenance shall be performed per the Standard Erosion Control Specification.
- C. Contractor to verify silt fence outlet placement at low points as they exist or develop. Additional silt fence outlets may be required to prevent erosion during and after construction and land disturbance activities. If additional silt fence outlets are necessary, Contractor to add additional silt fence outlets per Engineer, NCDEQ Erosion Control Inspector, or Owner direction at no additional cost to the Owner.

3.4 TEMPORARY DIVERSION DITCHES AND SLOPE DRAINS

- A. Install temporary diversion ditches as shown on the drawings, details and per the Standard Erosion Control Specification.
- B. Where shown on the drawings, install rolled erosion control blankets and rock check dams per the details and the Standard Erosion Control Specification.
- C. Install temporary slope drains per the drawings and the Standard Erosion Control Specification where runoff from diversion ditches enters the sediment basins, as shown on the drawings.
- D. Maintenance shall be performed per the Standard Erosion Control Specification.

3.5 SKIMMER BASINS

- A. Install skimmer basins as shown on the drawings per the details and the Standard Erosion Control Specification.
- B. Maintenance shall be performed per the Standard Erosion Control Specification.

3.6 INLET PROTECTION

- A. Install Inlet Protection per the detail shown on Drawings and per the Standard Erosion Control Specification.
- B. Inlet protection shall be placed at the upstream side of any pipe or structure discharging outside of the disturbed limits. See Drawings for location.

3.7 CONSTRUCTION ENTRANCE

- A. Install construction entrance per the detail shown on Drawings and per the Standard Erosion Control Specification.

B. Shall be maintained in a condition to prevent tracking or direct flow of mud onto adjacent roadways.

3.8 STOCKPILES

A. Install stockpiles per the detail shown on Drawings and per the Standard Erosion Control Specification.

B. Stockpile height shall not to exceed 15 feet and side slopes shall be 2 (H) to 1 (V) or flatter.

C. Stockpile shall have a minimum double row of silt fence as shown on Drawings.

3.9 GROUND STABILIZATION

A. Contractor shall provide ground stabilization per the Standard Erosion Control Specification and in accordance with the table below:

Site Area Description	Stabilization Time Frame	Stabilization Time Frame Exceptions
Perimeter Dikes, Swales, Ditches, and Slope	7 Days	None
High Quality Water (HQW) Zones	7 Days	None
Slopes Steeper Than 3:1	7 Days	If Slopes are 10' or less in length and are not steeper than 2:1, 14 Days
Slopes 3:1 or Flatter	14 Days	7-Days for slopes greater than 50-ft in length
All other areas with slopes flatter than 4:1	14 Days	None (except for perimeters and HQW zones)

3.10 TEMPORARY SEEDING

A. Temporary Seeding is to be placed and maintained over all disturbed areas prior to Permanent Sodding per the detail shown on Drawings and per the Standard Erosion Control Specification

B. Maintain Temporary Seeding until such time as areas are approved for permanent seeding. As a minimum, maintenance shall include the following:

1. Fix-up and reseedling of bare areas or re-disturbed areas.
2. Mowing for stands of grass or weeds exceeding 6 inches in height.

END OF SECTION 31 25 00

SECTION 321813 - SYNTHETIC TURF SURFACING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Synthetic turf surfacing, for installation as a drainable recreational surface, including:
 - a. Aggregate base course.
 - b. Perimeter board.
 - c. Synthetic turf.
 - d. Turf infill.

1.2 REFERENCES

- A. ASTM International (ASTM): www.astm.org:
 - 1. ASTM D1335 - Test Method for Tuft Bind of Pile Yarn Floor Coverings.
 - 2. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.
 - 3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Conference: Conduct conference at Project site following award of contract. Review methods and procedures related to synthetic turf surfacing installation including, but not limited to, construction schedule, availability of materials, equipment and facilities needed to make progress and avoid delays, installation procedures, inspection procedures, and coordination with other work.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Shop Drawings: Provide installation details including roll and seaming layout, methods of attachment and details at penetrations and terminations
- C. Samples: For each type of synthetic turf surfacing indicated.
 - 1. Minimum 12-by-12-inch- square sample of synthetic turf surface with edge attachment and carpet seam.
 - 2. 1/2 lb samples of base course and infill component material. Label sample identifying the material, its source, and evidence of compliance with specified product characteristics and testing

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Installation Schedule: Showing planned commencement and completion dates for each portion of the Work; include critical dates indicated on Owner's project schedule.
- C. Warranty: Sample warranty specified in this Section.

SECTION 33 11 00 - WATER UTILITY DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Materials, Installation, and Testing shall be in accordance with City of Raleigh standards and specifications. See Appendix A City of Raleigh Public Utilities Department Handbook (CORPUD) sections on Domestic Water.
 - 1. Please note the highlighted text in the sections provided within this Project Manual are from the published CORPUD and are not indicative of any special requirements of the Project.
 - 2. All references to pay items, allowances, and Contract language within the CORPUD are not applicable to this project and should be omitted from the bid.
- B. Section 31 23 17 Trenching
- C. Section 31 23 19 Dewatering
- D. Section 31 23 24 Flowable Fill

1.2 SUBMITTALS

- A. Product Data: For each type of the following manufactured or supplied products required:
 - 1. Pipe Materials
 - 2. Fittings, gaskets, and other appurtenances

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials including but not inclusive of pipe, fittings, gaskets, etc. shall be provided in accordance to the water material standards provided in the Water Materials section of the CORPUD.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installation shall be coordinated with Engineer and NC State inspectors for schedule inspections prior to being backfilled.

3.2 INSTALLATION

- A. Installation per respective CORPUD section.

3.3 FIELD QUALITY CONTROL

- A. All Chlorination, Hydrostatic, and Bacteriological preparation and testing shall be performed per the CORPUD Water Construction Standards.
- B. Engineer shall be notified of testing schedule and results.
- C. No additional payments will be made for failed tests.

END OF SECTION 33 11 00

SECTION 33 30 00 – SANITARY SEWER UTILITY DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Materials, Installation, and Testing shall be in accordance with City of Raleigh standards and specifications. See Appendix B City of Raleigh Public Utilities Department Handbook (CORPUD) sections on Sanitary Sewer.
 - 1. Please note the highlighted text in the sections provided within this Project Manual are from the published CORPUD and are not indicative of any special requirements of the Project.
 - 2. All references to pay items, allowances, and Contract language within the CORPUD are not applicable to this project and should be omitted from the bid.
- B. Section 31 23 17 Trenching
- C. Section 31 23 19 Dewatering
- D. Section 31 23 24 Flowable Fill

1.2 SUBMITTALS

- A. Product Data: For each type of the following manufactured or supplied products required:
 - 1. Pipe Materials
 - 2. Fittings, gaskets, and other appurtenances
 - 3. Manholes
 - 4. Cleanout lids
 - 5. Ring and covers

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials including but not inclusive of pipe, fittings, gaskets, etc. shall be provided in accordance to the sewer material standards provided in the Sewer Materials section of the CORPUD.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installation shall be coordinated with Engineer and NC State inspectors for schedule inspections prior to being backfilled.

3.2 INSTALLATION

- A. Installation per respective CORPUD section.

3.3 FIELD QUALITY CONTROL

- A. All testing shall be performed per the CORPUD Construction Specifications for Sewer Mains
- B. Engineer shall be notified of testing schedule and results.
- C. No additional payments will be made for failed tests.

END OF SECTION 33 30 00

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 GENERAL NOTES

- A. All storm drainage structures, related piping and accessories shall be in accordance with the State of North Carolina Department of Transportation standards and supplemented with any applicable NC State standards. If discrepancies exist, they should be brought to the Engineer's attention immediately.
- B. Refer to construction drawings for number, location and details of all proposed structures and pipes.

1.2 RELATED DOCUMENTS

- A. Materials, Installation, and Testing shall be in accordance with NCDOT and NC State standards and specifications.

1.3 SUMMARY

- A. Section includes but not limited to the following items and appurtenances shown on drawings and specified in this Section:
 - 1. Pipe and fittings.
 - 2. inlets and outlets.

1.4 DEFINITIONS

- A. RCP: Reinforced Concrete Pipe.
- B. NCDOT: North Carolina Department of Transportation.
- C. HDPE: High Density Polyethylene.

1.5 SUBMITTALS

- A. Product Data: Manufacturer information describing part, accessories, connections and any standard details.
- B. Manufacturer's Instructions: Special procedures required to install specified products.
- C. Shop Drawings: Indicate Part Sizes, connection sizes, elevations and connection parts.
- D. Manufacturer's Certificate: Products meet or exceed specified requirements.
- E. Qualifications Statements:
 - 1. Qualifications for manufacturer, and installer.
 - 2. Manufacturer's approval of installer.
- F. Field quality-control reports.
- G. Project Record Documents: Record actual locations of catch basins, drop inlets, yard inlets and grate/rim and invert elevations.
- H. Operation and Maintenance Data: Submit any special requirements for maintenance.

1.6 QUALITY ASSURANCE

- A. Perform Work according to State of North Carolina Department of Transportation and NC State standards.
- B. Fabricator: Company specializing in fabricating products specified in this Section with three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.

- B. Store according to manufacturer's instructions.
- C. Protect any UV sensitive materials from sunlight by using manufacturer recommendations.

1.8 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 Owner's Representative no fewer than (72) hours in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's Representative's written permission
- B. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Pipe and Fittings: ASTM C 76. Pipe and special fittings installed with 10 feet or less cover over top of pipe shall be Class III, and all other pipe and special fittings shall be Class IV. Basis of acceptance of reinforced concrete pipe shall be the 0.01" crack.
 - 1. Bell-and-spigot ends and sealant joints with ASTM C 990, bitumen or butyl-rubber sealant.

2.2 PIPE OUTLETS

- A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NCDOT Section 1042 "Riprap Materials". See plans for Class/Sizing.
- B. Filter Stone: According to NCDOT Section 1005 "General Requirements for Aggregate", #57 or #67 clean stone as specified on plans.
- C. Energy Dissipaters: Broken, irregularly sized and shaped, graded stone according to NCDOT Section 1042 "Riprap Materials". See plans for Class/Sizing.

2.3 HDPE PIPE AND FITTINGS

- D. HDPE Pipe and Fittings: All HDPE pipe shall conform to ASTM F2648 and be dual wall, smooth interior pipe with soil tight gaskets and fittings. Fittings shall conform to ASTM F2306 where applicable.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are per NCDOT Standard Specifications.

3.2 EXAMINATION

- A. Verify that excavations, dimensions and elevations are as indicated.
- B. Check pipes for cracks or other compromising features.
 - 1. Any irregularities shall be reported and approved prior to installation.

3.3 PREPARATION

- A. Correct over-excavation with coarse aggregate.
- B. Prepare base in accordance with applicable NCDOT standard.

3.4 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage 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 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Laser Equipment: Contractor shall utilize laser equipment to ensure that piping is installed at elevations and slopes indicated on plans.
- G. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping at invert elevations as specified in the storm drainage table.
 - 3. NCDOT Standard Specifications Division 3, Section 300 or one of the following.
 - 4. Install reinforced-concrete piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 5. Install HDPE Piping according to ASTM D2321 "Standard Practice for Underground Installation of thermoplastic Pipe for Sewers and Other Gravity-Flow Applications"

3.5 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join reinforced-concrete piping according to ACPA's "Concrete Pipe Installation Manual" or NCDOT
 - 2. Join HDPE piping according to ASTM and Manufacturer's Recommendations to ensure a soil tight joint.

3.6 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, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.7 CONNECTIONS

- A. Make connections to existing underground manholes.
 - 1. Make branch connections from side into underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
2. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED STORM DRAINAGE 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 and Structures: Excavate around manholes and structures as required and use one procedure below:
 1. Remove manhole or structure and close open ends of remaining piping.
 2. Remove top of manhole or structure down to at least 48 inches below final grade. Fill to within 12 inches of top with stone or gravel. Fill to top with concrete.
- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

- A. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 1. Use identification tape or non-detectable warning tape over all underground lines outside building footprint in the backfill approximately 18" to 30" above the service pipe, but a minimum of 10" and a maximum of 24" below finished grade.
 2. Use detectable warning tape over ferrous and nonferrous piping and over edges of underground manholes. Tape all underground lines outside building footprint directly on top of the pipeline and permanently secured to the pipeline at 10' intervals.
 3. Use insulated copper tracer wire or other approved conductor installed adjacent to underground nonmetallic piping and metallic pipe with compression gasket fittings installed underground. Access shall be provided to the tracer wire, or the tracer wire shall terminate aboveground at the end of the nonmetallic piping. The tracer wire size shall not be less than 10AWG and the insulation type suitable for direct burial. The tracer wire size shall be copper single conductor 10AWG minimum and the insulation type suitable for direct burial with type "UF" (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box or manhole.

3.10 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 reports 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. 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. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
 - b. Option: Test concrete piping according to ASTM C 924. C. Leaks and loss in test pressure constitute defects that must be repaired.
 - c. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

3.11 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 33 41 00

SECTION 33 49 13 - STORM DRAINAGE STRUCTURES

PART 1 - GENERAL

1.1 GENERAL NOTES

- A. All storm drainage structures, related piping and accessories shall be in accordance with the State of North Carolina Department of Transportation standards, and supplemented with any applicable NC State standards. If discrepancies exist they should be brought to the Engineer's attention immediately.
- B. Refer to construction drawings for number, location and details of all proposed structures and pipes.

1.2 RELATED DOCUMENTS

- A. Materials, Installation, and Testing shall be in accordance with NCDOT and NC State standards and specifications.

1.3 SUMMARY

- A. Section includes but not limited to the following items and appurtenances shown on drawings and specified in this Section:
 - 1. Catch Basins.
 - 2. Drop Inlets.
 - 3. Junction Boxes/Manholes.
 - 4. Headwalls.
 - 5. Accessories.
 - 6. Stormwater Structures.
 - 7. Concrete.

1.4 DEFINITIONS

- A. RCP: Reinforced Concrete Pipe
- B. NCDOT: North Carolina Department of Transportation.

1.5 SUBMITTALS

- A. Product Data: Manufacturer information describing part, accessories, connections and any standard details.
 - 1. Provide back up calculations or data from the Yard Inlet and Trench Drain grates proposed.
- B. Manufacturer's Instructions: Special procedures required to install specified products.
- C. Shop Drawings: Indicate Part Sizes, connection sizes, elevations and connection parts.
- D. Manufacturer's Certificate: Products meet or exceed specified requirements.
- E. Qualifications Statements:
 - 1. Qualifications for manufacturer, and installer.
 - 2. Manufacturer's approval of installer.
- F. Field quality-control reports.
- G. Project Record Documents: Record actual locations of catch basins, drop inlets, yard inlets and grate/rim and invert elevations.
- H. Operation and Maintenance Data: Submit any special requirements for maintenance.

1.6 QUALITY ASSURANCE

- A. Perform Work according to State of North Carolina Department of Transportation and NC State standards.
- B. Fabricator: Company specializing in fabricating products specified in this Section with three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store according to manufacturer's instructions.
- B. Protect any UV sensitive materials from sunlight by using manufacturer recommendations.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins, drop inlets, and headwalls according to manufacturer's written rigging instructions.

1.8 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 Owner's Representative no fewer than (72) hours in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's Representative's written permission.
- B. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 CATCH BASINS

- A. All catch basins to be precast in accordance with the NCDOT standard specifications.
- B. Catch Basins Lids and Frames:
 - 1. Materials: Cast Iron
 - 2. Lid: Shall be in accordance with applicable NCDOT standard detail as noted.
 - 3. Nominal Lid and Frame Size: *Varies*, see signed construction drawings.
- C. Connections
 - 1. All connections to be in accordance with the NCDOT standard specifications.

2.2 DROP INLETS

- A. All drop inlets to be precast in accordance with the NCDOT standard specifications.
- B. Drop inlet Lids and Frames
 - 1. Materials: Cast Iron
 - 2. Lid: Shall be in accordance with applicable NCDOT standard specifications.
 - 3. Nominal Lid and Frame Size: *Varies*, see signed construction drawings.
- C. Connections
 - 1. All connections to be in accordance with the NCDOT standard specifications.

2.3 JUNCTION BOXES/MANHOLES

- A. All drop inlets to be precast in accordance with the NCDOT standard specifications

- B. Connections
 - 1. Connections to be minimum soil-tight.
 - 2. All connections to be in accordance with NCDOT standard specifications.
 - C. Lids and Frames:
 - 1. Shall be in accordance with applicable NCDOT standard specifications
- 2.4 HEADWALLS
- A. Materials
 - 1. Reinforced Concrete. To be precast in accordance with the applicable NCDOT standard specifications.
 - B. Connections
 - 1. Connections to be minimum soil-tight.
 - 2. All connections to be in accordance with NCDOT standard specifications.
 - C. Design
 - 1. Design of headwall to be completed by registered Professional Engineer licensed in North Carolina.
 - 2. Contractor to submit shop drawings to Engineer and Owner for approval. Engineer to only approve shop drawings on the basis of dimensions and size. Engineer not responsible for any footing, shoring or structural aspect of headwall.
- 2.5 INLINE PVC DRAINAGE BASINS (YARD INLETS)
- A. Materials
 - 1. PVC meeting ASTM D1784 standards
 - 2. Joints meeting ASTM D3212
 - 3. Gaskets meeting ASTM F477
 - 4. Grates: Ductile Iron
 - B. Connections
 - 1. All connections must be soil tight.
 - C. Sizing
 - 1. All Inline PVC Drains and Grates must be sized to convey at least the flow shown on the Drawings.
- 2.6 MODULAR TRENCH DRAIN
- A. Materials
 - 1. Modular system from one single manufacturer that can provide a continuous slope trench to match the length shown on the Drawings and meet flow requirements below.
 - 2. All grates shall be stainless steel, heel safe (per ASME A112.6.3) and meet all requirements of the American Disabilities Act.
 - 3. Drain body should be resistant to both traffic loads and UV impacts.
 - B. Sizing
 - 1. Drain and grate(s) must be sized to convey at least the flow shown on the Drawings.
 - 2. Trench drain shall provide drain performance without the need for bypass drains or excessive ponding (more than 2") during the flow shown on the Drawings.
- 2.7 ACCESSORIES
- A. Any other required accessories for installation shall be engineer approved prior to installation.

2.8 STORMWATER STRUCTURES

- A. Cast-in-Place Concrete, Stormwater Structures: Construct of reinforced-concrete bottom, walls, and top; according to ASTM C 890 structural loading; of depth, shape, dimensions, and appurtenances indicated.
- B. Steps: Provide steps as shown on the Drawings in manholes, risers, transition cones, and transition top sections in accordance with NCDOT STD 840.66. Steps shall be spaced at 16" O.C.
- C. Energy Dissipaters: Refer to Drawings for shape and sizing; Design in accordance with NC Erosion and Sediment Control Planning and Design Manual.

2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, 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 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) 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: 50 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 A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are per NCDOT Standard Specifications.

3.2 EXAMINATION

- A. Verify that excavations, dimensions and elevations are as indicated.
- B. Check structures for cracks or other compromising features.
 - 1. Any irregularities shall be reported and approved prior to installation.

3.3 PREPARATION

- A. Correct over-excavation with coarse aggregate.
- B. Prepare base in accordance with applicable NCDOT standards.

3.4 INSTALLATION

- A. Installation Standards: Install Work according to NCDOT standards and manufacturer recommendations. If discrepancies exist they should be brought to Engineer's attention immediately.

3.5 FIELD QUALITY CONTROL

- A. Request inspection by Engineer prior to back filling any aggregate.
- B. If inspections indicate that Work does not meet specified requirements, remove Work, replace and request additional inspections.
- C. Provide a signed and sealed as-built survey by a licensed Land Surveyor in North Carolina for all locations, lengths, sizes and inverts of all storm drainage structures and piping. Land surveyor should also indicate any and all underground utilities encountered during excavation, including elevations tied to local control.

3.6 CLEANING

- A. Clean interior of structures of dirt and superfluous materials. Flush with water.

END OF SECTION 33 49 13



NC State University

Doak Field Enhancements

1081 VARSITY DR | RALEIGH | NORTH CAROLINA 27606

Project Manual – Volume 3 (Appendices) Construction Documents

SCO CONTRACT NUMBER: 22-24384-01A
NC STATE PROJECT NUMBER: 202120015
EWINGCOLE PROJECT NUMBER: 20220400

January 29, 2024

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Designer Waste Information Form

Project Name:		
Project Designer:		Date:
This form is to be completed by the designer and included with SD documents. Waste Management Plan will be based off of this form.		
Waste Type (Condition of waste can determine category. Damaged Universal Waste can become Hazardous Waste)	Present at Site (Y/N)	Comments
Hazardous Waste and Material		
Asbestos		
Chemical Waste (liquid and solid)		
Lead Containing Paint/ Lead Based Paint Chips/ Lead Debris		
PCB containing items (ballasts, caulk, etc.)		
Mercury contaminated debris/ piping/ P-traps		
Broken fluorescent lamps		
Universal Waste		
Mercury containing items (batteries, switches, etc.)		
Batteries (all types)		
Fluorescent Lamps - Intact		
Non-Regulated Waste		
Drywall		
Insulation		
Broad loom carpet		
Vinyl composition tile		
Acoustic ceiling tile		
Treated wood and MDF		
Other Regulated Waste		
Refrigeration equipment		
Tires		
Recyclable		
White goods (lab refrigerators to be disposed of)		
Roofing materials (asphalt, shingles, gravel, metal) non-ACM or lead		
Oil		
Metal (fixtures, piping, ductwork, studs, wiring)		
Cardboard		
Untreated wood		
Aggregate, concrete, brick, asphalt		
Carpet tile		
Non-PCB ballasts		

SEWER MATERIAL STANDARDS

I. GENERAL MATERIAL

Current specifications of the American Society for Testing Materials (ASTM), American Water Works Association (AWWA), the American National Standards Institute (ANSI), the American Association of State Highway and Transportation Officials (AASHTO), and Ductile Iron Pipe Research Association (DIPRA) shall apply in all cases where material is covered by an item in these specifications. All material used shall conform fully to these current standards or be removed from the job at the direction of the Public Utilities Director.

Pipe specimens shall be subjected to tests by an independent testing laboratory at such time as the Public Utilities Department may direct or as specified herein. Pipe not meeting these specifications will be ordered removed by the inspector, and such pipe shall be immediately removed from the job site and not transported to any portion of the project being constructed.

These specifications are not to be considered as proprietary in any way. When a particular brand is listed, it is only used as an aid in describing the type of material being requested.

2. PIPE MATERIALS (Gravity Mains Only)

a. Centrifugally Cast Fiberglass Reinforced Polymer Mortar (CCFRPM) Pipe

Centrifugally Cast Fiberglass Reinforced Polymer Mortar (CCFRPM) Pipe shall conform to ASTM D3262 for CCFRPM pipe manufactured of "Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) materials and to the following requirements.

1. CCFRPM pipe shall be as manufactured by HOBAS Pipe USA or approved equal.
2. CCFRPM pipe shall only be allowed for 18" diameter and larger pipe.
3. Pipe shall be suitable for laying condition as shown in standard detail S-1 at the depth indicated on the Drawings. Pipe manufacturer to verify pipe selection and document to the Engineer prior to ordering and manufacture of pipe.
4. Pipe shall conform to ASTM D2412 for minimum stiffness and external loading characteristics.
5. Couplings, fittings, and push-on joints shall be manufactured with flexible elastomeric seals conforming to the requirements of ASTM D4161 and ASTM F477 and shall meet or exceed the pipe class at the location of its installation.
6. Pipe joint shall be push-on type couplings unless specified otherwise.
7. Pipe shall meet the minimum requirements of ASTM D3681 and ASTM D3262. Manufacturer shall provide complete 10,000-hour test results on pipe produced at the proposed location of manufacture. Results shall reflect that the pipe has a minimum allowable strain of no less than .9% at fifty years when tested in accordance with ASTM D3681 and ATM 3262
8. Normal production pipe for this project shall not incorporate raw materials that are not in compliance with ASTM D3681 and ASTM D3262
9. Interior of the pipe shall be manufactured using a non structural resin with a minimum allowable elongation of 50% when measured in accordance with ASTM D638. The liner nominal thickness shall be 40-mils.
10. Exterior pipe surfaces shall be comprised of a layer of sand and resin to provide UV protection to the exterior.

11. For pipe installed in steel encasement pipe joint shall be flush type and capable of meeting the above requirements.

b. Ductile Iron Pipe and Fittings

Ductile iron pipe and fittings used for sanitary sewers shall be manufactured in accordance with AWWA Standards C-150 and C-110 respectively. The minimum pressure class pipe shall be class 250 or a greater class may be required based upon the depth of cover and laying conditions. Pipe shall be supplied in 18 or 20 foot nominal lengths. Pipe and fittings shall have a minimum working pressure of 250 psi, and minimum iron strength of 30,000 psi. Ductile iron may be used for any sewer main 8-inch and larger. Pipe joints shall be the "Push-on" type manufactured in accordance with AWWA Standard C-111-95.

Interior Linings for Ductile Iron Force Mains and Sewer Interceptors

All force mains, fittings, and gravity interceptors 12-inches and larger shall be lined with an amine cured novalac ceramic epoxy containing at least 20% by volume of ceramic quartz pigment. The lining material shall have a permeability rating of zero when tested in accordance with Method A – ASTM E96-66, Procedure A with test duration of 30 days. The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. Within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal DFT. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface shall also be dry and dust free. The lining shall not be used on the faces of the flanges (if applicable).

Due to the tolerances involved, the gasket area and spigot end up to 6-inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum of PROTECTO Joint Compound or approved equal. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

The number of coats of lining material applied and the touch up and repair of the lining shall be as recommended by the manufacturer. The pipe manufacturer shall provide a certification attesting that the application meets or exceeds the requirements of these specifications.

Lining material shall be PROTECTO 401, or approved equal.

c. PVC Gravity Sanitary Sewer Pipe

PVC gravity sanitary sewer pipe and related fittings shall be manufactured in accordance with all the requirements of ASTM D-3034-98 SDR 35 Type PSM polyvinyl chloride sewer pipe and fitting. PVC gravity sewer pipe may be used for 8, 10, 12 or 15 inch mains and shall be supplied in 12.5 foot lengths with bell-and-spigot joints. ASTM F679-95 shall establish the requirements for 18, 21, 24 and 27-inch diameter PVC, SDR 35 gravity sewer pipe. The length of joints shall be at least 11 feet for the larger PVC pipe, unless approved differently by the Public Utilities Director. All fittings shall use rubber gaskets, which conform to the requirements of ASTM F477-99.

3. PIPE MATERIALS (Force Mains)

a. Ductile Iron Pipe and Fittings

All Ductile Iron sewer force mains shall be pressure class or thickness class ductile iron pipe designed in accordance with AWWA Standard C-150. Design shall be done for external and internal pressures separately, using the larger of the two for the next design thickness. An additional allowance shall be made for corrosion and casting tolerances. The thickness design for external and internal pressures shall use the following conditions:

- 1) 3 feet minimum cover or as shown on the plans;
- 2) Laying condition - Type 1;
- 3) A minimum working pressure of 150 psi for pipes 16 inches and smaller in diameter, and for 24 inches and larger pipe, the design working pressure shall be as determined by the Public Utilities Director, and
- 4) A surge pressure of 300 psi.

All calculations for thickness shall be in accordance with AWWA Standard C-150, and the calculations shall be submitted to the Public Utilities Director for approval prior to shipping any pipe. The minimum thickness shall be pressure class 350 for pipes 6 inches through 12 inches and pressure class 250 for pipes 16 inches and larger in diameter.

The ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA Standard C-151. The ductile iron pipe shall be supplied in nominal lengths of 18 or 20 feet.

Ductile iron pipe shall be externally bituminous coated in accordance with AWWA C-151.

Pipe joints shall be mechanical or "push-on" manufactured in accordance with AWWA Standard C-111.

Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacture to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

All materials used in the production of the pipe are to be tested in accordance with AWWA Standard C-151 for their adequacy within the design of the pipe, and certified test results are to be provided to the City upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, McWane Cast Iron Pipe Company or approved equal.

Restrained joints shall be TR Flex or **HP LOK** as manufactured by U.S. Pipe, **Lok-Ring** or **Flex-Ring** as manufactured by American Pipe, Super-Lock as manufactured by Clow, **Bolt-Lok** or **Snap-Lok** as manufactured by Griffin or approved equal.

Interior Linings for Ductile Iron Force Mains

All force mains and fittings shall be lined with an amine cured novalac ceramic epoxy containing at least 20% by volume of ceramic quartz pigment. The lining material shall have a permeability rating of zero when tested in accordance with Method A – ASTM E96-66, Procedure A with test duration of 30 days. The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. Within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal DFT. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface shall also be dry and dust free. The lining shall not be used on the faces of the flanges (if applicable).

Due to the tolerances involved, the gasket area and spigot end up to 6-inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum of PROTECTO Joint Compound or approved equal. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

The number of coats of lining material applied and the touch up and repair of the lining shall be as recommended by the manufacturer. The pipe manufacturer shall provide a certification attesting that the application meets or exceeds the requirements of these specifications.

Lining material shall be PROTECTO 401, or approved equal.

b. Polyvinyl Chloride (PVC) Force Main Pipe and Fittings

Pipe and fitting size, pressure class and DR shall be as indicated on the drawings.

PVC Materials shall comply with ASTM D1784 with a cell classification of 12454-B.

PVC force mains 4"-12" shall conform to AWWA C900 and the following requirements:

1. outside diameter shall conform to Ductile Iron pipe.
2. Pipe shall be a minimum of pressure class 200 with a minimum standard dimension ration of DR14.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C100 or C153 and have mechanical joints. Fittings shall be made of gray-iron or ductile iron. Interior of fittings shall be lined with Protecto 401 as specified above.

PVC force mains 14"-24" shall conform to AWWA C905 and the following requirements:

1. Outside diameter shall conform to Ductile Iron pipe.
2. Pipe shall be a minimum of pressure class 200 with a minimum standard dimension ration of DR14.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C100 or C153 and have mechanical joints. Fittings shall be made of gray-iron or ductile iron. Interior of fittings shall be lined with Protecto 401 as specified above.

4. STEEL PIPE (AERIAL and BORED)

Steel pipe for aerial creek crossings shall be high strength steel, helical or straight seam welded manufactured in accordance with ASTM A 139 and consisting of grade “B” steel with a minimum yield strength of 35,000 psi. Thickness, diameter, and allowable spans shall be according to Detail S-12.

Boring installations shall be high strength steel, spiral welded or smooth-wall seamless manufactured in accordance with ASTM A252 and consisting of grade 2 steel with a minimum yield strength of 35,000 psi. The minimum inside diameter of steel encasements shall be eight inches greater than the inside dimension of the carrier pipe. The minimum casing pipe wall thickness shall be 0.375” for bored encasement and in accordance with the table provided below. Thicker encasement pipe may be required by the North Carolina Department of Transportation, railroads, or other agencies.

Carrier Pipe Nominal Diameter (inches)	Encasement Minimum Inside Diameter (inches)	Encasement Nominal Wall Thickness (inches)
6	14	0.375
8	16	0.375
10	18	0.375
12	20	0.375
14	24	0.375
16	26	0.500
18	30	0.500
20	32	0.500
24	36	0.625
30	42	0.625
36	48	0.750
42	56	0.875

The outside of steel pipe for aerial crossings shall be coated with 1 coat of a compatible acrylic polyurethane with a total dry film thickness of 2 – 5 mils per coat. The Acrylic Polyurethane coating shall be Tnemec Endura Shield Series 73, or approved equal. Primer shall be applied as recommended by the manufacturer.

No coatings required for buried or bored encasements but must conform to the noted wall thickness in the table above. All encasement pipe must be approved by the appropriate controlling agency (i.e. NCDOT, RR, etc.) prior to ordering the material.

All carrier piping shall be restrained joint ductile iron TR Flex as manufactured by U.S. Pipe, Lok-Ring or Flex-Ring as manufactured by American Pipe, Super-Lock as manufactured by Clow, Bolt-Lok or Snap-Lok as manufactured by Griffin or approved equal. One joint of restrained pipe must extend beyond the ends of the encasement pipe for boring installations. The restrained joint pipe shall be from manhole to manhole in aerial installations. The minimum inside diameter casing pipe shall be eight inches greater than the inside dimension of the carrier pipe.

Both ends of the casing shall be mortared. Metal "spider" pipe alignment devices shall be installed in all casings with a minimum of two spiders per pipe joint one fourth of the pipe joint length in from both the bell and spigot ends. See Detail S-39.

5. CURED IN PLACE PIPE LINING (CIPP)

CIPP lining may be allowed in lieu of replacing the existing downstream sewer main with Protecto 401 lined DIP or PVC pipe when a new forcemain discharges to an existing sanitary sewer main,

When allowed, the CIPP must adhere to the following specifications.

References:

The latest revision of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Society of Testing Materials (ASTM)
 - a. D790 Test Method for Flexural Properties of Unreinforced Plastics and Electrical Insulation Materials
 - b. D2412 Test Method for determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 - c. F1216 Practice for Rehabilitation of Existing Pipe Lines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

Fabricate a flexible tube to a size that when installed will neatly fit the internal circumference of the conduit specified. Allowance shall be made for circumferential stretching during insertion.

The minimum length shall be that deemed necessary by the contractor to effectively span the distance from the inlet to the outlet of the respective manholes. The contractor shall verify the lengths in the field before impregnation. Individual inversion runs can be made over one or more manhole sections as determined in the field by the contractor and approved by the Engineer.

Furnish a general purpose, unsaturated, polyester resin and catalyst system compatible with the reconstruction inversion process that provides the cured physical strengths specified. CIPP lining shall be Insituform by Insituform Technologies, INC., Inliner by Inliner USA, Inc., KM-Inliner by Spiniello Limited, Inc. or Cure-Line by pipelining Products, Inc. or approved equal.

Physical Strength:

<u>U.S. Licensor Standard</u>	<u>Results</u>
Flexural Stress	#101 (Modified ASTM D-790) 4,500 psi
Flexural Modulus of Elasticity	#101 (Modified ASTM D-790) 250,000psi

Design Thickness:

The liner shall be designed in accordance with the applicable provision of the referenced ASTM standards as structural pipe linings for “fully deteriorated gravity pipe conditions” and shall meet the following design conditions:

1. AASHTO H-20 Live Load with two trucks passing for FFP in streets.
2. Soil weight 120 pounds per cubic foot. Coefficient of friction $K'=.130r$ for the installed depths.
3. Estimated maximum groundwater levels at the height of the manholes.
4. Service temperature range shall be 40-150 degrees F.

6. MANHOLES AND RELATED MATERIALS

Manholes will be precast reinforced concrete. Eccentric or concentric cones may be used on 8 through 12-inch mains. Concentric cones will be used on all 15 inch and larger mains. These different type manholes shall conform to these specifications and the City of Raleigh Standard Details. All manholes located outside public right-of-way must be **three feet** above the 100-year flood or be sealed as per Details S-24 & S-27. “Candy cane” vent stacks on sewer manholes must be “factory” fabricated and “hot dipped” galvanized, NOT field fabricated and galvanized. All manholes with vent stacks shall be water tight per Detail S-24. All Cam Lock manhole covers outside the 100-year flood plain must be vented with one 1-inch hole in the cover and as per Detail S-27. All manhole covers installed within streets, parking lots, and other paved areas shall have only one 1-inch hole, which shall be off center and fitted with a rubber grommet, unless seal-down manholes are required.

Interior Linings for Precast Reinforced Concrete Manholes

All sanitary sewer interceptor/outfall manholes **on lines 12-inches and larger**, and manholes receiving a sanitary sewer force main discharge shall be internally coated with a **polyurea/polyurethane coating. Duramer 1030** shall be applied in one coat of a 20% solids, deeply penetrating, dual-component polyurea primer (0.5 – 1.0 mils dry film thickness, 150 ft²/gal), one intermediate coat of a dual component polyurea (50-100 mils dry film thickness, 50 ft²/gal) and one top coat of a 65% solids, two-part polyurea (7.5-10 mils dry film thickness, 125 ft²/gal). All coats can be applied by brush, spray, or roller. **Sherflex Elastomeric Polyurethane shall be applied according to manufacturer’s recommendations.** Polyurea/polyurethane coatings shall be Duramer 1030 as manufactured by SewerKote, **Sherflex Elastomeric Polyurethane as manufactured by Sherwin-Williams**, or approved equal.

a. **Precast Reinforced Concrete Manholes**

The concentric and eccentric manholes shall be designed and manufactured in accordance with ASTM C478-97. Manhole diameters shall be 4, 5, or 6 feet in diameter as determined by the table within Sewer Design standards for main size or depth. The walls shall be a minimum of 5 inches thick and have a 6-inch minimum base. O-ring or "ram neck" joint seal shall be used for all manhole joints. All exterior joints shall be wrapped with a butyl resin sealant of 8” width. The "O" ring joint shall conform to the requirements of ASTM C443-98. A flexible rubber boot shall be supplied with the manholes to tie the pipe to the barrel section. These gaskets and clamps shall meet the requirements of ASTM C923. See Detail S-24 – S-27.

The manufacturer shall submit drawings showing the reinforcing, pipe openings and other details for approval by the Public Utilities Director. Also, the manufacturer shall provide

certified test reports indicating that the materials comply with the requirements of ASTM C478-97. "Extended base" precast sections must comply with Detail S-21 dimensions and equivalent reinforcing.

b. Related Materials

- 1) Manhole rings and covers shall be manufactured to the dimensions shown on the Details S-25 through S-27 and shall be made from Class 30 gray iron, meeting the requirements of ASTM A48-94ae1. All covers must be domestically cast and so indicated by manufacturer name and "USA" in castings. Covers shall have "DANGER PERMIT REQUIRED – CONFINED SPACE DO NOT ENTER" cast onto the face as shown in Detail S-25. All manhole rings on flat-top manholes shall be cast into the manhole top, as shall be the flange for the vent stack, if applicable. See Details S-24. **Cam Lock covers shall be used on all manholes that are within easements. See details 24 & 27.**
- 2) Manhole steps shall be made from reinforcing steel which is rubber plastic coated to provide for safer footing. These steps shall be furnished in accordance with the Detail S-28 and the applicable OSHA regulations. Steps shall also be provided on outside of raised manholes when top elevation is greater than three (3) feet above existing ground elevation. All traffic bearing castings must be Class 35 or greater.
- 3) Cement used in masonry or reinforced concrete units shall be Type I, CSA normal, meeting ASTM C150-99, unless otherwise approved by the Public Utilities Director.
- 4) Concrete shall be only plant-mixed or transit-mixed concrete conforming to ASTM C33-99ae1 as to aggregates and to ASTM C94/C94M-99e1 for ready-mixed concrete.

Concrete shall be of three types as based on 28-day compressive strength:

Type AA	4500 psi.
Type A	3000 psi.
Type B	2500 psi.

Concrete shall be air-entrained, unless specified otherwise, with 4 to 6% air. Retarders and accelerators shall be used only as directed by the engineer.

Concrete used for structures such as sewage lift stations and other reinforced concrete structures shall meet all applicable provisions of the NCDOT specifications regarding manufacturer, delivery and placement.

- 5) Steel reinforcing for concrete structures shall meet all applicable provisions of the NCDOT specifications as to manufacture, fabrication and placement.
- 6) Mortar used for sewer structures shall conform to ASTM specification C144-99 as to aggregate and strength. Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No mortar that has stood beyond forty-five minutes shall be used. Proportion by volume for different kinds of work shall be:

Brick Masonry - 1 part cement to 2 parts sand

Pointing - 1 part cement to 1 part sand

- 7) Rubber boot sleeves shall meet or exceed ASTM C923 for connecting pipes to thru the barrel section of the manhole. Boot sleeves shall have stainless steel expansion bands and pipe clamps that meet or exceed ASTM C923 and A167.
- 8) Manhole inverts shall be constructed with a width equal to that of the effluent pipe, height to the springline and invert “shelves” from that point upward at a 60 deg. angle to the manhole walls. The invert shall be brushed and troweled that a minimum energy loss occurs in the manhole from invert roughness. “Bowl” shaped invert will not be allowed.

7. MISCELLANEOUS MATERIALS

a. PVC Sewer Service Pipe

PVC sewer service pipe shall be schedule 40 PVC including the clean-out stack provided that a bronze clean-out slotted plug for location purposes.

b. PVC Sewer Pipe and Saddles

PVC sewer pipe, saddles and adapters shall conform to the requirements of ASTM D3034-98. The saddle shall be installed in accordance with Standard Details S-31 and S-32.

c. Sewer Air Release/Vacuum Breaker Valve Material

Air release/vacuum breaker valves on sewer force mains shall be in accordance with Detail S-9.

d. Concrete Structures and Access Hatches

All other concrete structures and access hatches installed within highway right of ways shall be H-20 load rated.

CONSTRUCTION SPECIFICATIONS FOR SEWER MAINS

As part of the requirement to obtain construction approval for sewer main extensions, the engineer shall affix the appropriate permit sticker to the original drawings. **The various permit stickers are included in appendix D.**

The requirements contained in this section shall apply to sanitary sewer main installations constructed for the Public Utilities Department or for private developers who may or may not dedicate the sewer improvements to the City. All necessary construction permits must be obtained before construction may begin in accordance with the North Carolina State Law. A sewer plug permit must also be obtained.

Any Contractor performing work within the City of Raleigh or City of Raleigh Merger Areas such as Garner, Knightdale, Wendell, Zebulon, Wake Forest, and Rolesville , shall have on each job site a copy of these specifications.

1. SCOPE OF WORK

- a. The contractor shall furnish all materials, equipment, and labor for excavation, installation, backfilling of sewer mains and related appurtenances as shown on the plans. The Public Works Department and/or Public Utilities Department shall conduct all City inspections on main extension projects.
- b. It shall be the contractor's responsibility to notify the Public Utilities and Public Works Departments at least twenty-four hours in advance of beginning any construction work on any project. The contractor must call the Public Utilities Department at 996-4540 and Public Works Department at 996-6810 and give the location, project name, individuals name, company name, start date and indicate if it involves a sewer extension and state the start date. Contractors must call the Public Utilities Inspections staff at 996-2737 at least twenty-four hours in advance for an inspection in the Garner, Knightdale, Wendell, Zebulon, Wake Forest, and Rolesville Utility area.
- c. Once construction has begun, the contractor shall contact Public Works at 890-3030 each morning by 9:00 a.m. to notify where and what will be done that day. The City requires a 24 hour notice prior to an inspection. Any work requiring inspector's observation outside of the normal work day, shall be charged at the current inspector hourly rate.
- d. **In all Sewer Bypass Pumping operations, a bypass plan sealed by a N.C. Professional Engineer must be submitted for approval to the Public Utilities Department prior to pumping operations (Plans may be submitted to administration staff at One Exchange Plaza, Suite 620, Raleigh, NC 27601) Pumps should be sized to handle the peak daily flow (2.5 times the average daily flow) for the line or area of work. The contractor shall secure pumps from a pump supplier according to the provided flow information. Pumping operations must be monitored 24 hours a day for each day of the pumping operation by qualified personnel in order to respond to problems or failures. 100% redundancy is required for pumping operations. In addition, back up pumps are to be connected to the bypass force main to facilitate immediate use upon failure of the primary pumps. Sewer service outages must be scheduled one week in advance and may not last longer than eight hours.**
- e. If a developer, engineer or contractor proceeds with the main installation prior to permit issuance the City requires the main to be reinstalled and the developer, engineer or

contractor shall be fully liable for all actions and costs, including prosecution by the City or the State for proceeding with installation prior to issuance of appropriate permit(s).

- f. "Field changes" are not considered approved by the Public Utilities Department unless revised plans have been submitted to the Public Utilities Department, reviewed and approved. Therefore, the contractor that proceeds with construction prior to this approval is at his/her own risk.
- g. Contractors working (excavation, boring, or other subsurface breach) around or in the vicinity of sewer force mains 8 inches in diameter or larger shall be required to physically spot the existing line to be verified by P.U.D. distribution staff or inspection staff. If other existing lines sizes are in question of conflict the contractor shall be directed by P.U.D. staff of the level of subsurface investigation needed to locate the existing line.

2. GENERAL TESTING REQUIREMENTS

- a. The City may perform and shall require the contractor to perform, such destructive and nondestructive testing, as it deems necessary in order to inspect the materials and workmanship. See specific testing requirements within this section. These tests shall be in accordance with the procedures established by ASTM and AASHTO. The City shall reserve the right to modify the procedures in testing ditch and backfill compaction to allow a deeper test to be made by using the sand-cone method and/or nuclear testing gauges.
- b. All new sanitary sewer mains must be cleaned to the satisfaction of the inspector by jetting or balling prior to final inspection and acceptance by the City.
- c. Prior to final inspection all sanitary sewer mains shall be camera inspected. In areas where the manholes are installed within the street, the camera inspection shall take place just prior to the final lift of surface course asphalt. Failed inspections will require a follow up inspection and subsequent re-inspection fee.

3. SEWER CONSTRUCTION PLUGS

- a. A sewer plug permit must be obtained prior to beginning construction. See General Policies and Regulation Section for application.
- b. Mechanical plugs (non-pneumatic) must be installed for the duration of construction of any sanitary sewer extension. Plugs are to be installed on the upstream end of the new main at the first manhole from the existing tie-in, until final acceptance.
- c. All plugs must be securely tied off with steel cable within the manhole and must have a secure marking attached to the plug indicating the utility contractor to whom the plug belongs.
- d. All plugs must be monitored during construction to insure the plug is functioning as required.
- e. Prior to removing the plug, the contractor must sign a plug removal form verifying that the sewer facilities are sufficient and functionally complete. All plugs must be removed by the contractor upon acceptance that the sewer facilities are sufficiently functionally complete

to accept flow and PRIOR to the mains above the plug location being placed into service and/or accepting any flow of sewage.

4. HANDLING AND STORAGE OF MATERIALS

- a. The contractor shall be responsible for the shipping and storing of all sewer materials. Any material which is damaged or defective shall be replaced by the contractor at the contractors' own expense.
- b. The loading and unloading of all pipe, manholes and other accessories shall be in accordance with the manufacturer's recommended practices and shall at all times be performed with care to avoid any damage to the material.
- c. The contractor shall locate and provide the necessary storage areas for materials and equipment. If private property is being used for storage areas, then the contractor must have the written consent from the owner. Without this written consent, all material and equipment shall be stored within the existing rights-of-way and easements of the project. Pipe may not be prestrung along job site; it must be delivered to and removed from job site each day.
- d. All materials, once on the job site, shall be stored in accordance with the manufacturer's recommendations. All PVC sewer pipe shall be protected from the sun's ultra violet rays if stored on the job site longer than twenty days.
- e. All pipes shall be kept free of dirt and other debris. Any damage relating to the coating of the various materials for sewer and water mains shall be repaired in a manner approved by the City. Machined manhole frames and covers shall remain intact until construction is complete.
- f. The contractor shall be responsible for safeguarding and protecting all material and equipment stored on the job site. The contractor shall be responsible for the storage of materials in a safe and professional manner to prevent injuries, during and after working hours, until the project is complete.

5. BARRICADES, SIGNS AND STREET PROVISIONS

- a. Signs, barricades, warning lights, guard rails and flaggers shall be employed as necessary when construction endangers either vehicular or pedestrian traffic. These devices shall remain in place until the traffic may proceed normally again. The contractor shall hold the City harmless for any damages or injuries caused by the construction of sewer mains.
- b. Detours shall be set up and maintained by the contractor under the direction of the City of Raleigh Department of Transportation and North Carolina Department of Transportation. Notice must be given a week in advance of the detour so that necessary notification of the traveling public may be made. The contractor will furnish all barricades, signs, lights and other safety devices to protect his/her construction. The contractor is in no way relieved of liability for providing this protection because the detour is approved by others.
- c. Construction work zone signs and signing procedures shall conform to the MUTCD and supplements and to all applicable federal, state and local codes. The contractor shall be responsible for securing the necessary permits from the City's Transportation and

Inspections Departments for all work to be performed in the public rights-of-way.

6. PROPERTY PROTECTION

Trees, fences, poles and all other property shall be protected unless their removal is authorized, and any property not authorized for removal, but damaged by the contractor, shall be restored by the contractor to the owner's satisfaction. Existing manholes within the work zone and outside of the pavement shall be protected by orange safety fence.

7. GENERAL CONSTRUCTION SAFETY

- a. The contractor and any subcontractors shall be responsible for the total compliance with all federal, state and local ordinances, laws and regulations as related to safe construction practices and to protecting the employees and the public's health and safety.
- b. The contractor shall ensure that all Occupational Safety and Health Administration (OSHA) regulations and standards are followed during all phases of the construction project.
- c. The City shall not be responsible for contractor's adherence to OSHA regulations and standards. However, the City may report known violations or unsafe practices to the appropriate enforcement agency.
- d. The contractor shall furnish safety equipment necessary to inspect the work including, but not limited to ladders, gas detectors/oxygen sensors, blowers, etc.

8. ENCROACHMENT CONTRACTS AND PERMITS

- a. Prior to actual construction, the contractor shall acquire the necessary encroachments from NCDOT when working within the rights-of-way of state system roads or highways. The encroachment permit shall be kept on the job site at all times.
- b. The contractor shall be responsible for securing all other local and state and federal permits required for the utility construction. The contractor must have an approved set of permitted construction plans on site at all times.
- c. The contractor must have an approved set of permitted construction plans on site at all times.
- d. For projects which require construction plan approval, all environmental permits and NCDOT encroachments must be provided prior to plan approval. See general policies and regulations section Page 25.

9. PAVEMENT REMOVAL AND REPLACEMENT

- a. Any pavement that must be removed shall be cut along straight lines with the appropriate saw cut machine. A street cut permit is required. The removal and replacement of the pavement shall conform to the information shown in Details S-1 thru S-4.

- b. All cuts of City streets must be patched the same day with a temporary or permanent patch. Once work has been completed, all temporary patches shall be replaced with permanent ones. All work from patching shall be cleaned up at the same time of patching
- c. The City of Raleigh shall perform density tests as needed to determine contractor's compactive efforts. See Notes 2 and 3 of details S-3 & S-4.
- d. Pavement cuts shall be confined to a maximum trench bottom width as shown in Details S-4 & S-5, plus 12 inches on either side.
- e. Asphalt compaction shall be done with a gasoline or diesel powered smooth drum asphaltic roller.
- f. Pavement cuts within NCDOT Right of Way shall not be performed without the proper encroachment permits on site. All patching of NCDOT pavements shall conform to the approved on site encroachment permit.

10. EXCAVATION

- a. Prior to any excavation or construction, the contractor shall locate all existing utilities in the field. If help is needed in locating utilities operated by the Public Utilities Department, the contractor should contact the Operations Division (996-2737).
- b. Trench width shall be a minimum of twelve inches plus outside diameter of pipe and a maximum of twenty-four inches plus outside diameter of pipe, unless additional trench width is required by OSHA. Trench width shall be measured between the faces of the cut at the top elevation of the pipe bell as shown in Details S-4 & S-5.
- c. Trench bottom conformation, where no special bedding is required, may be that referred to herein as flat bottom where the trench bottom is excavated slightly above grade and cut down to pipe grade by hand in the fine-grading operation. Where the trench bottom is inadvertently cut below grade, it shall be filled to grade with an approved material and thoroughly tamped.
- d. The maximum length of open trench shall be no more than three-hundred feet unless approval is obtained from the Public Utilities Director.
- e. The contractor shall, at the contractor's own expense, keep all trenches free from water during the excavation for construction of sewer mains. The water shall be pumped out of the trench or build check dams to keep it out of the ditch in such a manner as not to cause injury to the public health, private property or the work in progress. Erosion control measures shall be taken during this pumping.
- f. In trenches where water is present or dewatering is required, the trench shall be stabilized with #67 stone. When the contractor encounters material during trench excavation, at the opinion of the inspector or Public Utilities Director, that is unsuitable (i.e. "muck"), this material shall be replaced with material that is considered suitable prior to the pipe laying operations. In this case, construction fabrics may be required to prevent the migration of side support away from the pipe.
- g. Safety and convenience of the public necessitate that all work, including excavation, be done in such a manner as to cause minimum traffic interruption, both pedestrian and

vehicular. Utilities such as fire hydrants, valves, etc., shall be accessible at all times. Gutters and drains shall be left open and clear at all times, and the contractor shall be responsible for all drainage around his work. Unless specifically waived by the Public Works Department, provisions shall be made to maintain vehicular traffic on all streets in which work is in progress, and suitable walkways shall be maintained for pedestrian travel.

- h. Sheeting or bracing shall be used wherever necessary to prevent failure of the trench banks. All sheeting shall conform to AASHTO and OSHA safety standards. The decision of the Engineer relative to bracing for the protection of property of the City shall be binding upon the contractor. The removal of sheeting shall be done in such a manner as to minimize the loss of friction between the backfill and trench walls

11. ROCK EXCAVATION

- a. Rock shall be defined as that solid material that cannot be excavated, in the opinion of the Public Utilities Director or Engineer, by any means other than drilling and blasting, drilling and wedging, or boulders and broken concrete exceeding ½ cubic yard in volume. Rock shall be excavated to the same limits as earth excavation except that the trench shall be made six inches lower than the outer bottom of the pipe, and this six inches shall be refilled with six inches of #67 stone and thoroughly compacted to the sub-grade level. All blasting shall be done after coordination with the City Inspector and subject to all applicable regulations. The City reserves the right to require the removal of rock by means other than blasting where any pipe or conduit is either too close to or so situated with respect to the blasting as to make blasting hazardous. Rock taken from the ditch shall immediately be hauled away and disposed of by the contractor.
- b. Blasting procedures shall conform to all applicable local, state and federal laws and ordinances. A blasting permit shall be obtained from the City of Raleigh Fire Marshal's Office, prior to any blasting. The application shall be obtained 24-hours before any blasting takes place, and the Fire Marshal may specify the hours of blasting. The contractor shall take all necessary precautions to protect life and property, including the use of an approved blasting mat where there exists the danger of throwing rock or overburden. The contractor shall keep the explosive materials that are on the job site in specially constructed boxes provided with locks. Failure to comply with this specification shall be grounds for suspension of blasting operations until full compliance is made. No blasting shall be allowed unless a galvanometer is employed to check cap circuits. Where blasting takes place within five-hundred feet of a utility, structure or property which could be damaged by vibration, concussion or falling rock, the contractor shall be required to take seismograph readings and to keep a blasting log containing the following information for each and every shot.
 - 1) Date of shot
 - 2) Time of shot
 - 3) Crew Supervisor
 - 4) Number and depth of holes
 - 5) Approximate depth of overburden
 - 6) Amount and type of explosive used in each hole
 - 7) Type of caps used (instant or delay)
 - 8) The weather
 - 9) Seismograph instrument and readings

- c. This blasting log shall be made available to the Public Utilities Director or Engineer upon request and shall be kept in an orderly manner. It shall be the contractor's responsibility to have adequate insurance to cover any damages resulting from blasting so to save the City of Raleigh harmless from any claims.

12. TRENCH PREPARATION

- a. Trench excavation shall conform to the line and depth shown on the plans. The trench shall be properly braced and shored so that workers may work safely and efficiently. When water is being pumped from the trench, the pump discharge shall follow natural drainage channels, drains or storm sewers. In no case may trench water or groundwater be pumped into or allowed to enter the sanitary sewer system. See erosion control section for appropriate siltation prevention measures prior to pumping.
- b. The width and type of trench may vary with the depth of cut, and the trench shall be constructed in accordance with the dimensions and other information shown on Details S-4 & S-5.
- c. Pipe Clearance in rock shall be a minimum of six inches on each side and bottom for mains fifteen inches in diameter and less. For larger size mains, the minimum clearance shall be nine inches on the sides and bottom.
- d. If unstable conditions are encountered, the trench shall conform to the requirements as stated in this Handbook.

13. PIPE INSTALLATION

- a. The pipe material listed above shall be installed in accordance with the manufacturer's recommendations and the requirements of these specifications.
- b. All sewer mains and manholes shall be laid to the line and grade shown on the plans.
- c. No deviations from line and grade shall be made, unless they have been approved by the Public Utilities Department or Engineer and identified on the "as-builts".
- d. The sewer pipe installation shall start at the outlet end and proceed upstream to the termination of the project as shown on the plans. The bell ends shall point upstream. Exceptions to this provision will be considered on a case by case basis, when requested in writing by the owner of the development at the time engineering construction plans are submitted to the City for review and approval. The development owner must agree to hold the City harmless. He must accept full responsibility for compliance with state and federal regulations of the Clean Water Act, including any associated penalties which could reach up to \$25,000/ day, for the release of wastewater from sanitary sewer to the environment, which are not connected to existing sewer due to the granting of an exception to the pipe laying sequence required in the Public Utilities Handbook. The development owner must further agree to not request building permits, if an exception is granted for that portion of the development, until connecting sewer is constructed and accepted by the City.

- e. While working on any part of an existing sewer main, the contractor shall maintain the existing sewage flow. No discharge of sewage to the storm waters will be allowed. Water for the flushing of new sanitary sewer mains must be obtained through a fire hydrant meter and must be pumped out and may not be discharged into the sanitary sewer system. Construction requiring existing sewer flow to be pumped from existing manholes shall be the responsibility of the contractor and must be approved prior to proceeding by the Public Utilities Director or the City Inspector according to **Section 1. d., Scope of Work for Bypass Pumping.**
- f. After the trench foundation has been properly graded with bell holes, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be properly repaired or replaced at the contractor's expense.
- g. The pipe interior shall be kept clean before and after installation by means approved by the Public Utilities Director or Engineer. Pipe ends shall be plugged at the end of each workday or when work is temporarily stopped. The plugs shall be watertight so the water and debris will be kept out.
- h. When installing a sewer main, the horizontal separation from any water main shall be ten feet. If this separation cannot be maintained due to existing conditions, the variation allowed is the water main in a separate trench with the elevation of the water main at least 18 inches above the top of the sewer and must be approved by the Public Utilities Director. All distances are measured from the outside diameter to outside diameter. Where it is impossible to obtain proper separation, or anytime a sanitary sewer passes over a water main, DIP materials or steel encasement extended 10' on each side of crossing must be specified & installed to waterline specifications.
- i. Maintain 24" min. vertical separation at all sanitary sewer & storm drain crossings. Where adequate separations cannot be achieved, specify DIP materials & a concrete cradle having 6" min. clearance (per COR PUD detail S-49)
- j. All other underground utilities shall cross water & sewer facilities with 18" min. vertical separation required
- k. Railroad crossings shall be made following all precautionary construction measures required by the railroad officials.
- l. All sewer crossings under state system roads shall be made in accordance with the requirements of NC DOT as defined in their encroachment permits.
- m. Where conditions are, in the opinion of the Public Utilities Department or Engineer, unsuitable for laying pipe because of weather or trench conditions, the Contractor shall be required to cease work until permission is given by the Public Utilities Director or Engineer for work to commence again, providing such conditions have been corrected.

14. LAYING CCFRPM GRAVITY SEWER PIPE

All CCFRPM pipe shall be installed per manufacturer recommendations and the following requirements:

- a. Do not exceed forces recommended by the manufacturer when joining pipe.

- b. Gasket shall be wiped clean prior to joining. Damaged, defective, or bulging gaskets shall be replaced with a new coupling.
- c. Wipe the plain end of pipe clean prior to insertion in the socket.
- d. Apply joint lubricant, as approved by the pipe manufacturer, to pipe end and elastomeric gaskets.
- e. For handling pipe, use textile slings or other suitable materials or a forklift. Use of cables or chains is not permitted. Damaged pipe will be rejected.
- f. Pipe shall be free of nicks, scratches, and gouges at the time of installation. Visible gouges shall be cause for rejection of pipe.

For depths of cover of 0' to 40' CCFRPM pipe shall be bedded in a minimum of 6" Class I material. Embedment and initial backfill shall be Class I material to 6" above the top of pipe. Backfill the remaining 6" of initial backfill with Class I, II, or III material. See Detail S-1.

15. LAYING PVC GRAVITY SEWER PIPE

The foundation for PVC gravity sewer pipes shall be a firm flat bottom trench of 4 inches of Class I material as defined in ASTM D2321-89(1995) compacted with bell holes. See Details S-2, S-3, & S-5. Class II material may be used if contractor can verify that this type of soil is native to the site by having soil tests made by a soil testing agency. Sample borings shall be taken on 200 feet intervals and to a depth equal to or greater than the trench bottom shown on the plans. The results must be approved by the Public Utilities Director prior to pipe installation.

16. LAYING PVC FORCE MAIN PIPE

Install C900 and C905 PVC pipe in conformance with AWWA C605. Clean bell and spigot ends prior to jointing. Ends of field cut pipe shall be beveled with file. Gasket shall be clean and lightly lubricated. Joint shall be made as recommended by the manufacturer.

17. LAYING DUCTILE IRON SEWER PIPE

- a. Ductile iron pipe shall be installed in accordance with the requirements of AWWA Standard C-600. See Detail S-4.
- b. Sewer pipe shall be laid to the line and grade shown on the plans. There shall be a minimum horizontal separation between water and sewer utilities of ten feet and a vertical separation of 18 inches.
- c. Protection shall be afforded to all underground and surface structures using methods acceptable to the Public Utilities Director or Engineer. This protection shall be furnished by the contractor at the contractors' own expense.
- d. Deviation from line and grade may be made on revised plans upon approval by the Public Utilities Department and identified on "as built" when such deviations arise from grade or line conflicts with existing utilities, structures or other sources of conflict.
- e. Subsurface explorations shall be made by the contractor at the direction of the Public Utilities Director or Engineer where it is necessary to determine the location of existing pipes, valves or other underground structures.
- f. Depth of pipe cover, unless shown otherwise on the plans shall be a minimum of three feet outside of travel ways and five feet inside of travel ways. Depth of cover shall be

measured from the established street grade or the surface of the permanent improvement to the top of the barrel of the pipe.

- g. After the foundation has been properly graded, bedded when applicable, and the bell holes dug, the pipe and accessories shall be carefully lowered into the trench by approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe and accessories shall be removed from the job. All damaged pipe shall be replaced at the expense of the contractor.
- h. installation of pipe and jointing of pipe shall be done according to manufacturer's recommendation with care being taken to provide uniform bearing for the pipe. Bell and spigot of pipe shall be cleaned and properly lubricated where a mechanical joint of a "push on" type joint is employed.
- i. Open ends of pipe shall be plugged with a standard plug or cap at all times when pipe installation is not in progress. Trench water shall not be permitted to enter pipe.
- j. Bell ends will face the direction of installation which must be upgrade unless otherwise directed by the Public Utilities Director or Engineer.
- k. Where conditions are, in the opinion of the City Inspector, unsuitable for pipe installation because of weather or trench conditions, the contractor shall be required to cease work until permission is given by the City Inspector for work to commence again providing such conditions have been corrected.

18. INSTALLING CIPP LINER

Installation Preparations

Adhere to the methods listed below to produce a high quality rehabilitated pipeline by the cured-in-place inversion method. The finished product is to be of highest quality and shall eliminate infiltration problems which exist in the existing wastewater pipeline.

Installation Preparation: The following installation preparation procedures shall be adhered to by the Contractor.

- a. **Cleaning of Sewer Line:** Remove debris from the sewer line in accordance with Public Utilities standards
- b. **Inspection of Pipelines:** perform inspection of pipelines shall be by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television. Carefully inspect the interior of the pipeline to determine the location of conditions which may prevent proper installation and it shall be noted so that these conditions can be corrected. Internal T.V. inspection shall be in accordance with Public Utilities standards
- c. **Bypassing Sewage:** Provide for the flow of sewage around the section or sections of pipe designated for reconstruction. The bypass shall be made in accordance with City of Raleigh Standards set forth in this handbook.
- d. **Line Obstructions:** Clear the line of obstruction such as solids, dropped joints, protruding service connections or collapse pipe that will prevent the installation. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the engineer prior to the commencement or the work.

Installation Procedure

- a. Designate a location where the reconstruction tube will be vacuum impregnate prior to the installation. Allow the engineer to inspect the materials and “wet-out” procedure. Use a catalyst system compatible with the resin and reconstruction tube.
- b. The wet out reconstruction tube shall be inserted through an existing manhole or other approved access by means of an inversion process and the application of hydrostatic head sufficient to fully extend it to the next designated manhole or termination point. Insert the reconstruction tube into the vertical inversion standpipe with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the reconstruction tube shall be turned inside out and attached to the standpipe so that a leak proof seal is created. The inversion head will be adjusted to be of sufficient height to cause the impregnate tube in the invert from manhole to manhole and hold the tube tight to the pipe wall, produce dimples at side connections and flared ends at the manholes. The use of a lubricant is recommended. Care shall be taken during the elevated curing temperature so as not to overstress the felt fiber. In certain cases, the contractor may elect to use a top inversion where the reconstruction tube is attached to the top ring and the standpipe is formed from the reconstruction tube itself.
- c. Curing: After inversion is completed, supply a suitable heat source and water recirculation equipment. Equipment shall be capable of delivering hot water throughout the section by means of a pressuring hose to uniformly raise the water temperature above the temperature required to affect a cure of the resin. The temperature shall be determined by the resin\catalyst system employed.
- d. Fit heat source with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Place a gauge between the impregnated reconstruction tube and the pipe invert at the remote manhole to determine the temperature during cure. Water temperature in the line during the cure period shall be as recommended by the resin manufacturer. Initial cure shall be deemed to be completed when inspection of the exposed portion of cured pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exothermic. The cur period shall be of a duration recommended by the resin manufacturer, as modified for the cured in place inversion process, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature continues.
- e. Cool down: cool the hardened pipe to a temperature below 100° F before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Care shall be taken in the release of the static head so that a vacuum will not be developed that could damage the newly installed pipe.
- f. Finish: the finished pipe shall be continuous over the entire length of an inversion run and be as free as commercially practicable from vision defects such as foreign inclusions, dry spots, pinholes and delaminating.
- g. Sealing pipe at manholes: if due to broken or misaligned pipe at the manhole wall, the new pipe fails to make a tight seal, apply the seal at that point. The seal shall be of a resin mixture compatible with the pipe.
- h. Service connections: Fully reopen the existing active service connections in each length of sewer following lining. Reopen service connections from inside the sewer by means of a closed-circuit television camera, controlled cutting device appropriate for CIPP lining and the rehabilitates sewer pipe. Clean and neatly cut openings flush with the lateral pipe. Liner penetrations of openings shall be watertight.
- i. Air test and Camera the main per specifications below.

19. SEWER LATERALS

- a. Pipe for 4 inch sewer laterals shall be PVC pipe or DIP. Where installation by boring is specified, four-inch ductile iron pipe shall be used. DIP (4" only) must be used for deep or shallow installations under the same standards as sewer mains. Aerial service installations shall be constructed of 4" DIP. A minimum grade of 1% shall be maintained with four and six-inch pipe. Each lateral shall be sealed at the end with an approved watertight plug. Lateral installation for four-inch services shall conform to Standard Detail S-30. A six-inch service lateral must connect to a manhole. All laterals shall be left exposed until the inspectors can verify the installation of each plug.
- b. Each sewer lateral shall be installed from the main to the street right-of-way line or easement line where a one piece combination wye and 1/8 bend and cleanout stack will be installed. The wyes on the laterals shall be sealed at the property line with a permanent plug.
- c. Trench support, bedding and backfill for laterals shall conform to the same specifications as those for sewer mains. **Class II, III, and IV materials may be used for PVC sewer lateral bedding in lieu of Class I materials.** The contractor shall properly backfill under all wye and lateral connections at the main. The lateral connection at the main shall be backfilled with #67 stone.
- d. Where laterals are bored, the face of the bore cut shall be a distance of five feet from the edge of the pavement on either side, unless approval to the contrary is given by the Public Utilities Director.
- e. Sewer laterals four inches in diameter shall be connected to the main by means of an in-line wye or a tap and saddle, installed over a hole cut in the top quadrant of the main at an angle of forty-five degrees, with respect to direction of flow. The hole shall be cut with a mechanical circle type saw cutter designed for the particular use and rendering a smooth, uniform cut with no damage to the main and which retrieves the coupon. See saddle installations on Standard Detail S-31.
- f. All 4" sewer services may be tapped directly into 8, 10, and 12-inch mains or manholes in accordance with Details S-31 and S-32. Taps can only be made by using a mechanical tapping machine or other approved device. All sanitary sewer service connections 6 inches and larger shall be made into manholes only. Service connections on mains 15 inches and larger are only allowed at manholes. Service clean-outs shall be located at the right-of-way line or the easement boundary line. The maximum vertical drop for a 6-inch service into a manhole shall be 10 feet.
- g. All laterals tapped on newly constructed mains shall be air tested with the main. All laterals tied to a newly constructed manhole shall be vacuum tested with the manhole or conduct a separate air or water head test before any plumber connections are made.

20. MANHOLES

- a. Manhole dimensions shall conform to those shown on Detail S-24. Manholes on all lines twelve inches in diameter or smaller shall have an inside diameter of four feet.

- b. Inverts shall be constructed with a width equal to that of the effluent pipe, height to the springline and invert "shelves" from that point upward at 60 deg. to manhole walls, it shall be so brushed and troweled that a minimum energy loss occurs in the manhole from invert roughness. The maximum grade on an invert of less than 2.5 feet shall be no greater than 6 inches across the manhole. "Bowl" shaped inverts shall not be allowed in the sanitary sewer collection system. What is this trying to achieve?
- c. Foundation for manholes shall be in accordance with Detail S-21, unless approval to the contrary is given by the Public Utilities Director.
- d. All manholes in road right-of-ways will be flush with grade not withstanding 100 year flood requirements. In easements, manholes will be a minimum of 12 inches above ground.
- e. All new manholes must be vacuum tested in accordance with the following procedure:
- 1) The Contractor shall furnish all labor, equipment, and any appurtenant items necessary to satisfactorily perform the vacuum test. All equipment will be approved for vacuum testing.
 - 2) All lifting holes shall be plugged with an approved non-shrink grout.
 - 4) All pipes entering the manhole shall be plugged. The contractor shall securely brace the plugs to keep them from being drawn into the manhole. All service connections tied to manholes shall also be vacuum tested with the manholes.
 - 5) The test head shall be placed inside the top of the cone section of the manhole and the seal inflated in accordance with the manufacturer's recommendations.
 - 6) Manhole vacuum tester shall be as manufactured by Cherne Manhole Testing or approved equal. A vacuum of 10-inches of mercury shall be drawn and the vacuum pump shut off. Inflate the compressor band to effect a seal between the vacuum base and the manhole cone section. Connect the vacuum pump to the outlet port with the valve open. With the valves closed, the time for the vacuum to drop to 9-inches of mercury shall not be less than that shown in the following table.

Manhole Depth	Diameter of Manhole		
	48" Dia.	60" Dia.	72" Dia.
10 Ft. or Less	60 Sec.	75 Sec.	90 Sec.
>10 Ft. but <15 Ft.	75 Sec.	90 Sec.	105 Sec.
>15 Ft.	90 Sec.	105 Sec.	120 Sec.

(Times shown are minimum elapsed times for a drop in vacuum of 1-inch of mercury).

- 7) If the manhole fails the initial test, necessary repairs shall be made with an approved non-shrink grout while the vacuum is still being drawn. Retesting shall proceed and continue until a satisfactory test is accomplished.
- f. All manhole rings on manholes other than flat-tops shall be bolted to the cone section and sealed down with asphaltic cement or “ram-neck. See Detail S-25.
- g. All manhole joints must be waterproofed with asphaltic cement or “ram-neck”. All exterior joints shall be wrapped with a butyl resin sealant of 8” width.
- h. All main and service pipe connections into manholes must be cored with a concrete coring machine and the pipe connection must be made with a flexible rubber boot.
- i. Adjustment rings used within streets shall be fixed with mortar or a urethane based manhole joint seal by A.I.T. or approved equal.

21. BACKFILLING

- a. The backfilling of the trench after the pipe installation and testing shall be in accordance with Details S-4 & S-5 & S-1 for the various pipe materials.
 - 1) For depths of cover of 0’ to 40’ CCFRPM pipe shall be bedded in a minimum of 6” Class I material. Embedment and initial backfill shall be Class I material to 6” above the top of pipe. Backfill the remaining 6” of initial backfill with Class I, II, or III material. See Detail S-1.
 - 2) The haunching for PVC pipes shall be with #67 stone (Class I material) 4 inches below and up to the springline of the pipe. Care shall be taken to work the haunching well under the bottom of the pipe. The initial and final backfill shall be with suitable native material. No rocks, boulders or stones four inches or larger shall be included in the backfill. The haunching shall be tamped to 95% standard Proctor density in six-inch lifts.
 - 3) For PVC sewer installations, Class II material may be allowed for the bedding, housing and initial backfill if the contractor can verify that this type of soil is native to the site by having soil tests made by a soil testing agency. Soil sample borings shall be taken as directed by the City inspector to a depth equal to or greater than the trench bottom elevation shown on the plans or in the specs. The results must be approved by the Public Utilities Director prior to pipe installation. The bedding and backfilling shall be in conformance with ASTM standards and the various soil classes are defined below:
 - (a) Class I - Angular, 6 to 40mm (1/4 to 1 1/2 inch), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone and crushed shells.
 - (b) Class II - Coarse sands and gravels with maximum particle size of 40mm (1 1/2 inch), including variously graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW and SP are included in this class. (GW - well graded gravel, GP - poorly graded gravel, SW - well graded sand, SP - poorly graded sand.)

- (c) Class III - Fine sand and clay type gravels, including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil Types GM, GC, SM and SC are included in this class. (GM - silty gravel, GC - clayey gravel, SM - silty sand, SC - clayey sand.)
 - (d) Class IV - Silt, silty clays and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials are not recommended for bedding, haunching or initial backfill on PVC pipes. (MH - silty soil with high liquid limit, ML - silty soil with low liquid limit, CH - clayey soil with high liquid limit, CL - clayey soil with low liquid limit.)
- 4) All backfill shall be compacted in six-inch lifts measured from the foundation to one foot above the top of the pipe and then in twelve-inch lifts to the top of the trench when in easements. Sewer mains in street rights-of-way shall be compacted in six-inch lifts all the way to the top of the trench.
 - 5) Material for backfilling shall be approved by the inspector. In areas where settlement or bearing capacity are not a major consideration, the engineer may give permission for a low grade of material to be backfilled from a point two foot above the top of the pipe, but in no event will excavated rock larger than four inches at any point be used for backfill material.
 - 6) Where backfill material is unsuitable, in the opinion of the Public Utilities Director or Engineer, the contractor may be directed to dispose of the unsuitable material and provide material suitable to the Public Utilities Director or Engineer.
 - 7) All backfill shall be compacted in six-inch lifts measured from the pipe foundation upward. Backfill for roadway shall be compacted to at least 95% of maximum soil density in those areas where the supporting capacity of the soil is of prime consideration. Laboratory determination of maximum soil density will follow the procedure of AASHTO T99-86. Field determination of the density of the soil in place shall follow the procedure of AASHTO T191-86 or T204-86. The result of any one test may be a minimum of 90% of maximum density, but the average of any three tests in an area shall be 95% of maximum density. All tests shall be conducted at the direction of the City Inspector, and the cost of such tests will be borne by the contractor with the provision that the City will test an area two times only where both tests fail. The contractor shall then be required to submit satisfactory evidence that his ditch compaction meets the specifications.

PVC Force mains

PVC pipe shall be installed in accordance with AWWA C605. At a minimum, all PVC pipe shall be installed at a Type 3 laying condition as specified by AWWA C605 for depth of installation from 4-ft to 10-ft measured from the top of the pipe. The Type 3 laying condition requires the pipe to be bedded on a minimum of 4-inches of select granular material that will conform to the bottom of the pipe. Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a 0.075 mm (No. 200) mesh sieve and no less than 95 percent by weight passing the 25 mm (1 inch) sieve. Pipe installation on a flat bottom trench is unacceptable.

Embedment material shall be compacted to the top of the pipe. When using mechanical compactors, avoid contact with the pipe. When compacting over the pipe crown, a minimum cover of at least 8-inches or more in conformance with the manufacturer's requirements shall be maintained over the top of the pipe prior to compacting. The maximum embedment sizing shall be limited to materials passing a 3/4-inch sieve for angular materials or 1-1/2-inches for rounded rock. Embedment materials consisting of select material or native soils shall be well drained, granular, free of rocks and other foreign materials and shall be selected and placed to prevent gouges, crimping, or puncture of pipe, joints or appurtenances.

22. SURFACE RESTORATION

- a. All disturbed surfaces and property thereon, shall be restored to a condition equal to that existing before construction began, and the contractor shall maintain and be responsible for all ditches in paved streets, curbs, gutters or sidewalks until the contractor repaves the trench cuts. The contractor, with permission of the inspector, may place temporary or permanent asphaltic material in the cut. Asphalt compaction shall be done with a gasoline or diesel powered smooth drum asphaltic roller.
- b. All easements will be seeded with grass and left so they can be mowed by conventional mowers, unless approved by the Public Utilities Department for rip-rap or other specified material. In remote areas, easements will be seeded with a quality fescue grass. In residential areas, easements will be seeded with either falcon or rebel fescue or leaf mulch at the request of property owner. The contractor shall guarantee a good uniform stand of grass and shall reseed any bare or thin spots. The contractor will be responsible for a one-year warranty on materials and workmanship.

23. EROSION CONTROL

Erosion control measures shall be performed by the contractor, conforming to the requirements of, and in accordance with plans approved by the State of North Carolina Department of Environment and Natural Resources, North Carolina Sedimentation Control Commission and City of Raleigh Inspections Department Erosion Control Division, and as per the erosion control plan portion of the construction drawings and these specifications. The contractor shall not allow mud and debris to accumulate in the streets. The sedimentation and erosion control plan and permit shall remain on site at all times. Should the contractor pump water from trenches during construction, appropriate siltation preventative measures shall be taken prior to the entry into any storm drain or stream. All materials used for erosion control shall be approved by the Engineer prior to installation by the contractor.

- a. Temporary and permanent erosion control measures shall be shown on the plans. Temporary and permanent erosion control work shall be coordinated throughout the project to provide effective and continuous erosion control throughout construction and post construction, which minimizes siltation of streams, lakes, reservoirs, other water impoundments, ground surface, or other property. Seeding and mulching shall be carried out immediately behind construction.
- b. Temporary erosion control measures shall include but not be limited to swaled easements, silt fences, crushed stone check dam devices, silt basins (sedimentation traps), mulching, earth berms, and rip-rap.

- c. Permanent erosion control measures shall include but not be limited to swaled easements, rip-rap, and seeding of disturbed areas.
- d. Erosion and siltation shall be controlled on projects by using swales to control run-off and convey run-off to controlled discharge points, by silt fences, rip-rap, crushed stone, and earth berms to contain silt, with pipe culverts where major access or haul roads cross drainage ditches or streams, silt basins where pipe lines cross drainage ditches or streams, and seeding and mulching will be performed as soon after pipe installation as possible. When temporary measures are removed after completion of the project the disturbed area must be stabilized, if necessary.

24. MAINTAINING SERVICE

When replacing or extending sewer mains, the contractor shall maintain existing service to all property being served through bypass pumping or other means of maintaining service.

25. GUARANTEE

The contractor shall guarantee all material, equipment and workmanship for a period of at least one year after final acceptance by the City. The Public Works Department's Construction Inspection Division is responsible for the issuance of final acceptance letters by the City.

For projects in Merger Areas the Public Utilities Department Construction Inspection Division is responsible for issuance of final acceptance letters.

26. WETLAND/ STREAM BUFFERS

Conditions of 401/404 permits shall be strictly followed to the satisfaction of Corp of Engineers. All Neuse Riparian buffers shall be maintained as required by NCDWQ.

27. TEST AND INSPECTION (GRAVITY SEWERS)

- a. Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras or other devices for visual inspections, and the lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade and have structural defects shall be corrected to meet these specifications. Manholes that are installed within the street shall be camera inspected just prior to the final lift of surface course asphalt.
- b. Sewer lines will be tested by using the low pressure air test. Sewer laterals will be tested along with the main. It is imperative that proper plugs be installed on the laterals at the cleanout stack. All plugs should be properly installed to withstand the test pressure. Mechanical plugs must be installed throughout the time of construction of any sanitary sewer extension, until final acceptance. All plugs must be securely tied off with steel cable within the manhole and must have a secure marking attached to the plug indicating the utility contractor to whom the plug belongs. All plugs must be removed by the contractor upon acceptance that the sewer facilities are sufficiently functionally complete so as to accept flow and PRIOR to the mains above the plug location being placed into service and/or accepting any flow of sewage.

- c. The low pressure air test in accordance with ASTM F1417 or C924 (F1417 for PVC and Ductile; C924 for Concrete Pipe) will be used on all mains and laterals. Prior to testing, the main shall be clean of debris (to the satisfaction of the inspector) and flushed with water. In doing the air test, it is necessary that plugs be secured properly and braced. In doing the air test, no person will be allowed in the main while it is pressurized. The line is to be pressurized to 4 psi initially and stabilized. After stabilization, the pressure will be decreased to 3.5 psi, and the inspector will determine how long it takes for the pressure in the line to drop to 2.5 psi.

To simplify the ASTM procedure, use the following table to determine the test time. If there are multiple sizes, add the various times together.

Normal Pipe Size (inches)	Time (Minutes/100ft.)
4	.3
6	.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3

If the pressure stays between 3.5 and 2.5 psi for the test time length, the pipe is acceptable. If not, the section is not properly installed. Correct and retest.

- d. A hydrostatic leakage exfiltration or infiltration test shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet. All tests shall be made in the presence of the contractor or his representative and the Public Utilities Director, City Inspector or Engineer.
- f. Materials and construction methods called for in these specifications are of such nature as to insure maximum protection for the sewer from infiltration. The contractor shall be responsible for the sewer conforming to the above limits for a period of one year from the date of final acceptance.
- g. When sanitary sewer services are installed as a part of the same approval of the sanitary sewer mains, such as in new subdivisions/annexation areas, the air test of the sewer mains shall be performed with the services and clean-outs in place. Services tied to a newly constructed manhole shall be vacuum tested with the manhole. Services not tested with newly constructed mains or manholes shall have a separate air test before any plumber connections are made.

28. DEFLECTION TESTING FOR PVC SEWER PIPES

No sooner than thirty days after final backfill installation, a deflection test shall be executed on the sewer line. The maximum allowable deflection shall be five percent for PVC sewer pipes. The test shall use a minimum of nine pronged mandrel pulled through the pipe. The mandrel size shall be calculated by (1-allowable deflection percent) x (Base Inside Diameter). The base inside diameter is the diameter as identified in the shop drawing or advertised pipe literature. It shall not include any additional reduction pipe diameter due to manufacturing tolerances.

The contact length of the mandrel shall be at least eight inches.

Any lines not meeting this test shall be corrected by the contractor and the test repeated.

29. PIGGING (FORCE MAIN SEWERS)

All new mains with gate valves must be pigged with a polyethylene "pig", 5#/cubic foot density, at the conclusion of installation.

The pig must be blown at the end of the main by means of the following:

- a. 4" main - 4" blow-off
- b. 6" main - 6" blow-off
- c. 8" and 12" main - blow-off assembly as shown on Standard Water Details W-21 & W-22
- d. 16" – 24" main – To be determined by the field inspector

The contractor installing the line shall write the name of the company and street name in which the work is taking place on the pig in a manner in which it will not rub off.

30. HYDROSTATIC TESTING (FORCE MAIN SEWERS)

- a. All main installations shall be pressure tested between each main line valve in accordance with the latest AWWA Standard C-600-87. The test shall be performed using a suitable pump and an accurate pressure gauge. Immediately upon completion of a section of main, 150 psi (\pm 5 psi) of pressure shall be applied and held for two hours. The acceptable leakage rate shall not exceed 0.092 gallons per inch of pipe diameter per 1,000 feet of pipe per hour.

Failure of the force main to comply with the above acceptable leakage rate shall require the contractor to replace any defective materials to insure a watertight installation. After any inadequacies have been corrected, the leakage rate will again be tested. This test shall be repeated until that portion of main is brought to compliance with the permissible leakage rate.

- b. Prerequisite conditions for inspection prior to testing shall be as follows:

- 1) Valves shall be properly located, operable, and at correct elevation. Valve boxes or manholes shall be centered over operating nuts, and the top of the box or manhole shall be at proper elevation.

- 2) Lines shall be properly vented where entrapped air is a consideration.

31. SEWER MAIN AND SERVICE STUB ABANDONMENT

Sewer service stub to a main shall be abandoned by removing the saddle and replacing the saddle with a 360 degree stainless steel sleeve. At in-line wyes the service lateral shall be cut within 12" of the wye and a mechanical cap installed on DIP/cast services or glued to PVC services and the abandoned wye to be surrounded with 1 ft³ of concrete. The remaining portion of the sewer service stub shall be removed from the main to the right of way line and shall be disposed of properly. Sewer main abandonment must be performed in accordance with a plan approved by the Public Utilities Department. Service stub and main abandonment require a stub permit for inspection by the Public Works Department 919-996-4540. Raleigh Public Utilities Department will oversee stub abandonment in the merger towns 919-996-4540.

General Requirements;

- A Property owner is responsible for proper abandonment of all unused existing service stubs.
- All abandoned meters are to be removed by the Raleigh Meters Division prior to service abandonment. (919-996-2742).
- The Raleigh Public Utilities operations staff will not abandon an existing service stub unless it is part of a service renewal as required by ordinance.
- For circumstances that may not be addressed by this clarification or a variance from this procedure please contact the Raleigh Public Utilities Department Development staff at 919-996-4540.

LICENSED UTILITY CONTRACTOR REQUIRED SERVICE ABANDONMENT PERMITS

Contractor installed domestic (3/4" thru 12"), irrigation water (3/4" thru 10"), sewer (4" thru 8") and fire hydrant (6") service stub;

Commercial; All domestic and/or irrigation, sewer and fire hydrant abandonment requires a stub permit for each connection to a water or sewer main.

Residential/Individual; All domestic water and/or irrigation and sewer service stubs abandonment installation requires a stub permit. Exception; Irrigation splits installed with a new domestic service. Irrigation splits on an existing tap requires a stub permit.

Demolition Permits; Plans are required to show all existing services to be abandoned included temporary construction water using existing meter(s). Plan review required.

Sewer Stubs in Easements; A licensed and bonded utility or plumbing contractor may install a sewer stub on a sewer main located within a dedicated easement and requires the issuance of a stub permit. Raleigh Ordinance 10-6082

Street cut permits are required for pavement repair in ROW.

City of Raleigh Capital Projects

A licensed utility contractor performing City contracted water or sewer main replacement work is not required to obtain a stub or street cut permit for abandoned services or mains.

Water and Sewer Main Abandonment

All water and sewer main abandonment requires plan submittal for review by the Raleigh Public Utilities Development Staff by submission of plans through the Raleigh Development Customer Service Center

32. SEALED AS BUILT PLANS

Certified surveyed "As built" plans and profiles, sealed by a Professional Land Surveyor, shall be furnished to the Public Works Department by the engineer upon completion and acceptance of the public main by the City and at completion of private systems. For development projects in the merger towns as-builts must be submitted directly to the inspector.

34. SEWER BACKWATER VALVE

Pursuant to NC State Plumbing Code, homes and other buildings constructed with sanitary sewer drains with an elevation lower than one (1) foot above the next upstream manhole in the sanitary sewer collection system must be equipped with a sewer backwater valve, installed at a location where it can be maintained. See Details S-38 & S-42.

WATER MATERIAL STANDARDS

1. GENERAL MATERIAL REQUIREMENTS Current specifications of the American Society for Testing Materials (ASTM), American Water Works Association (AWWA), Ductile Iron Pipe Research Association (DIPRA), American Association of State Highway and Transportation Officials (AASHTO), and the American National Standards Institute (ANSI) shall apply in all cases where material is covered by an item in these specifications. All material used shall conform fully to these current standards or be removed from the job at the direction of the Public Utilities Director.

Pipe specimens shall be subjected to tests by an independent testing laboratory at such time as the Public Utilities Department may direct or as specified herein. Pipe not meeting these specifications will be ordered removed by the inspector, and such pipe shall be immediately removed from the job site and not transported to any portion of the project being constructed.

Detail or shop drawings of fire hydrants, valves, air release valves, tapping sleeves and tapping saddles must be approved by the Public Utilities Department prior to installation.

These specifications are not to be considered as proprietary in any way. When a particular brand is listed, it is only used as an aid in describing the type of material being requested.

2. MATERIALS – WATER MAIN AND FITTINGS

a. Water Mains

All water mains shall be pressure class or thickness class ductile iron pipe designed in accordance with AWWA Standard C-150. Design shall be done for external and internal pressures separately, using the larger of the two for the next design thickness. An additional allowance shall be made for corrosion and casting tolerances. The thickness design for external and internal pressures shall use the following conditions:

- 1) 3 feet minimum cover or as shown on the plans;
- 2) Laying condition - Type 1;
- 3) A minimum working pressure of 150 psi for pipes 16 inches and smaller in diameter, and for 24 inches and larger pipe, the design working pressure shall be as determined by the Public Utilities Director, and
- 4) A surge pressure of 300 psi.

All calculations for thickness shall be in accordance with AWWA Standard C-150, and the calculations shall be submitted to the Public Utilities Director for approval prior to shipping any pipe. The minimum thickness shall be pressure class 350 for pipes 6 inches through 12 inches and pressure class 250 for pipes 16 inches and larger in diameter.

The ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA Standard C-151. The ductile iron pipe shall be supplied in nominal lengths of 18 or 20 feet.

The ductile iron pipe shall be cement-mortar lined with a sealcoat in accordance with AWWA Standard C-104. Ductile iron pipe shall be externally bituminous coated in accordance with AWWA C-151.

Pipe joints shall be mechanical or "push-on" manufactured in accordance with AWWA Standard C-111.

Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacture to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

All materials used in the production of the pipe are to be tested in accordance with AWWA Standard C-151 for their adequacy within the design of the pipe, and certified test results are to be provided to the City upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, McWane Cast Iron Pipe Company or approved equal.

Restrained joints shall be TR Flex or **HP LOK** as manufactured by U.S. Pipe, **Lok-Ring** or Flex-Ring as manufactured by American Pipe, Super-Lock as manufactured by Clow, **Bolt-Lok or Snap-Lok** as manufactured by Griffin or approved equal.

b. Fittings

All fittings shall be manufactured in accordance with AWWA C-110 or C-153 for ductile iron compact fittings. The fittings shall be tested and the manufacturer shall provide certified test results when requested by the City. This testing shall include hydrostatic proof testing of the fittings.

All fittings shall be mechanical joint with the exception of certain above ground piping which may require flange fittings. Mechanical joints shall be manufactured in accordance with AWWA Standard C-111.

All fittings shall be cast iron or ductile iron and shall have a minimum working pressure rating of 250 psi and minimum iron strength of 30,000 psi.

All fitting interiors shall be cement-mortar lined with a sealcoat in accordance with AWWA Standard C-104, and the outside shall be bituminous coated.

Restrained mechanical glands may be used where restraint is needed except when welded restraining rings are required. Restrained mechanical glands provide additional restraint, but do not take the place of required concrete blocking.

45° and 90° bends shall be allowed in the water distribution system for all line sizes when required.

c. Gate Valves

Cast iron or ductile iron resilient wedge style vertical or horizontal gate valves and tapping valves shall be used for all main line and hydrant branch valves in sizes from 6 inches through 24 inches. American, Mueller, Kennedy, AVK, Clow, M&H, and Waterous valves in accordance with AWWA C-509-94, C-515, or the appropriate AWWA standard

as applicable, shall be used. All resilient wedge valves shall have internal and external epoxy coating, O-ring seals at the stuffing box and bonnet to body and dual O-rings at the stem seal above the thrust collar.

Tapping valves shall be the same valves as gate valves listed above, subject to the standards, providing that tapping valves shall have the tapping ring.

Gate valves twelve (12) inches in diameter and smaller, shall be mechanical joint or hub-end all-bell. They shall be "O" ring, open-left valves of the non-rising stem type. These valves shall be designed for a minimum of 175 psi working pressure and 300 psi hydrostatic test pressure with a two (2) inch operating nut. Valves shall be cast iron or ductile iron.

Valves sixteen (16) inches in diameter or greater may be the horizontal gate type or butterfly type, as specified on construction plans, or gate valves as specified above.

Gate valves, horizontal gate valves or butterfly valves shall be used for all main line and hydrant branch valves in sizes 16 inches through 24 inches.

d. Valve Boxes

Adjustable valve boxes shall be class 35 gray cast iron and manufactured in accordance with ASTM A48 and be of the dimensions specified in Detail W-17 of these specifications. Lids shall have the word "Water" cast into the lid. See Detail W-18. All castings must be domestically cast and so indicated by the manufacturers name and "USA" cast into all sections of the valve box. All castings must meet or exceed AASHTO H-20 load rating. Total valve box weight shall be a minimum of 85 lbs and have a minimum lid weight of 25 lbs. **Mueller Model AJBV 5 adjustables are permissible.**

e. Butterfly Valves

Butterfly valves sixteen inches or greater than (16) inches in diameter shall be Class 150B and shall conform to the latest AWWA Standards C-504, as manufactured by Mueller, Kennedy, Pratt, **DeZURIK**, or **Val-Matic** for rubber sealed butterfly valves and valve operating assemblies. "O" ring seals shall also be used exclusively with worm gear.

All valve end connections shall be mechanical joint or victaulic, as required by the detail drawings. Valve seats shall be stainless steel, bronze mating or resilient material. Resilient seat shall be mechanically attached to the valve disc, or mechanically retained in the valve body. Resilient seat shall be fully field adjustable by mechanical means. The valve disc shaft shall be stainless steel or either stub or thru-shaft design. Shafts shall be provided with two-way disc thrusters that are fully adjustable from the outside. Valve shaft bearings shall be heavy duty bronze, properly fitted into hubs integrally cast in the body of the valves.

All butterfly valve **gear actuators** shall be according to **AWWA C-504**. The valve operator shall be furnished with a two-inch square operating nut, and be so mounted that the valve will open-left (counter-clockwise). The butterfly valve operator shall have AWWA stops, be suitable for submersible service and be sized in accordance with AWWA torque requirements for a full 150B rated valve.

The manufacturer of the butterfly valve shall be fully responsible for the satisfactory performance of the assembled valve and operator unit. The specified operators shall be factory mounted by the valve manufacturer and shipped to the job site as an operating unit. External painting, hydrostatic testing, travel stop adjustments and crating for shipment shall be in complete compliance with the latest AWWA specification for butterfly valves.

All butterfly valves shall be installed in a standard eccentric precast manhole (diameter appropriate with size valve). Standard Detail W-16

f. Fire Hydrants

Fire hydrants shall comply with AWWA C-502-94 as manufactured for the City of Raleigh by Kennedy, Mueller, Clow, American Darling.

City of Raleigh and all merger area fire hydrant nozzles shall have National Standard Threads.

The City of Raleigh may require fire hydrants to resist accidental and deliberate contaminations of the water supply.

All fire hydrants shall have 2-two-and one-half inch nozzles, and 1- 5” Storz connection nozzle. The nozzle shall be an integral part of the fire hydrant and must be furnished by the manufacturer or authorized distributor designated by the manufacturer. Storz connector shall have the following characteristics: brass hydrant nozzle connection; have hard anodized aluminum Storz ramps and lugs (hydrant and cap side); and require a high-torque Storz spanner wrench in order for the cap to be removed.

See Details W-5 through W-6 for hydrant information pertaining to each town.

The hydrant valve opening shall be five and one-quarter inches with no exceptions. Bronze to bronze threads shall be provided between the hydrant seat or seat ring and the seating attaching assembly. All hydrants must include cast or ductile epoxy lined shoe, rubber drain seals and positive, protective valve stop device.

Hydrants shall be open-left type and shall have a six-inch hub-end or mechanical joint elbow. The hydrant barrel shall be of sufficient length to provide a minimum of three and one-half feet of bury and be of the break-away impact type.

Fire Hydrant Colors

City of Raleigh public fire hydrants shall be painted solid red.

Town of Wendell public fire hydrants shall be painted safety yellow with high reflective aluminum silver caps, bonnets, and operating nuts.

Town of Zebulon public fire hydrants shall be painted red with silver bonnets and operating nuts.

Town of Wake Forest and Town of Garner public and private fire hydrants shall be painted safety yellow with silver caps and operating nuts.

Town of Knightdale public fire hydrants shall be painted solid red

Town of Rolesville public fire hydrants shall be shall be painted solid red
Operating nuts on hydrants connected to public mains 12" or larger shall be
painted black.

Operating nuts on hydrants connected to public mains of any other size shall be
painted silver.

g. Air Release Valves

Water Air release valves shall be two-inch Crispin Pressure Air Valves, Model P 20, with a vacuum check unit, or two-inch Val-Matic, Model VM-45, with a vacuum check unit or equal as approved by the Public Utilities Director. These valves shall be suitable for 150 psi working pressure and designed to allow air to escape automatically while the main is in service and under pressure. The valve shall be housed in a City of Raleigh approved eccentric manhole and shall be installed in accordance with Detail W-19 of these specifications. Air release valve locations shall be approved by the Public Utilities Department, or as shown on the plans. The engineer must field stake the air release location.

h. Tapping Sleeves and Tapping Saddles

Tapping sleeves shall be Mueller mechanical joint, Mueller Outlet Seal, American Uniseal, Kennedy Square Seal, or Clow F5205 or F5207. 100% stainless steel sleeves may also be used, as manufactured by **Smith-Blair, Romac, Ford, or JCM** provided that all metallic parts of the sleeves shall be 100% stainless steel including bolts. Ductile iron flanges may be included on sleeves or saddles. **Test assembly seals with water according to AWWA C-223.** All sleeves shall have a minimum of 150 psi working pressure. All taps shall be machine drilled--no burned taps will be allowed.

Tapping saddles may be used on mains 16-inches and larger. In 16 and 24 inch saddles as manufactured by Mueller, American, Kennedy and Clow tapping saddles shall be manufactured of ductile iron providing a factor of safety of 2.5 at a working pressure of 250 psi. In main sizes of 30-inch and larger, ductile iron tapping saddles as manufactured by American Pipe Company or US Pipe Company shall be utilized.

Saddles shall be equipped with a standard AWWA C-110-98 flange connection. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddle. Straps shall be of alloy steel. Saddles may be used for taps one-half the size of the main or less (i.e. 8-inch tapping saddle for use on a 16-inch main).

i. Water Service Connections

Water service pipe for 3/4 - to 2-inch connections shall be type "K" soft copper with no joints or couplings in the right-of-way. On these water services, the fittings shall be flared copper type brass fittings or compression type fittings.

1 1/2 inch and 2 inch taps may only be made with use of a double strap bronze saddle.

Corporation cocks for direct 3/4" and 1" taps may be used on ductile iron pipe and shall have AWWA Standard tapered threads. Unions shall be three piece copper to copper.

Curb stops used on gang meter assemblies shall be as manufactured by Mueller, Oniseal, Hayes NuSeal, Ford, A.Y. McDonald ball valve. All corporation stops and curb stops shall be bronze ball valves and shall be appropriate material to material corporation and curb stops as manufactured by Mueller, Ford, and A.Y. McDonald and must have a complete ball and installed in a valve box.

Curb stops are required for ¾" through 2" meters and shall be located 1' from the meter box on the street side. Curb stops shall be installed in a curb stop box as manufactured by Ford, A. Y. McDonald, or Trumbull.

Water meter gang assemblies of ¾" and 1" meters may be allowed on ¾-inch to 2-inch service connections and shall conform to the requirements shown in Detail W-26. A deviation from this standard may be warranted in some circumstances. Calculations will be required to support the deviation.

Service saddles shall be all bronze with double bronze straps and with a neoprene "O" ring gasket attached to the body. The clamp shall have corporation cock threads. These clamps shall be as Mueller H-16100 series, Jones J 979 or approved equal.

For services greater than 2 inches, the water service pipe shall be 4, 6, 8 or 12 inches in diameter and shall be of ductile iron pipe. Cast iron or ductile iron fittings shall be used on these services. All taps will be made by using the appropriate size tapping sleeve and valve. See Detail W-14. On a "dry line", the connection may be made with a "TEE and Valve" as shown in Detail W-15.

Coppersettors or copper meter yokes shall be 5/8 inch and 12 inches in height as manufactured by Ford or approved equal. All coppersettors shall have locking wings on the angle valve and be of the Ford angle check type.

Curb stops on gang meter assemblies shall be as manufactured by Mueller, Oniseal, Hayes Nuseal, Ford, and A.Y. McDonald. All corporation stops and curb stops shall be bronze ball valves and shall be appropriate material to material as manufactured by Mueller, Ford, and A.Y. McDonald.

j. Meters

All water meters shall be provided and installed by the City of Raleigh Public Utilities Department Meters Division.

k. Meter Boxes and Vaults

All meter boxes and vaults shall be constructed of cast iron, precast concrete, concrete block, high-density polyethylene, or cast-in-place concrete as on details W-23 thru W-35. Meter vault access doors shall be aluminum slam lock type as manufactured by Halliday, U.S.F. Fabrication, or approved equal.

Meter boxes and vaults shall not be placed within sidewalks or driveways unless no other alternatives are available and approval is obtained by the Public Utilities Director. Traffic rated lids and vaults shall be installed for all meters 1 ½" and larger.

The meter box must be set to grade. If for some reason, the grade is altered, then the meter box must be adjusted to match the new grade. This includes the addition of topsoil by a landscape contractor or homeowner, flower gardens, etc.

l. Steel Encasement Pipe

Steel pipe for boring installations shall be high strength steel, welded or smooth-wall seamless manufactured in accordance with ASTM A252 and consisting of grade 2 steel with a minimum yield strength of 35,000 psi. The minimum casing pipe wall thickness shall be 0.375” for bored encasement.

No coatings required for buried or bored encasements but must conform to the noted wall thickness in the table below. All encasement pipe must be approved by the appropriate controlling agency (i.e. NCDOT, RR, etc.) prior to ordering the material.

All carrier piping shall be restrained joint ductile iron. One joint of restrained pipe must extend beyond the ends of the encasement pipe. The minimum inside diameter of steel encasements shall be eight inches greater than the inside dimension of the carrier pipe. See the following table for encasement diameter and thickness:

Carrier Pipe Nominal Diameter (inches)	Encasement Minimum Inside Diameter (inches)	Encasement Nominal Wall Thickness (inches)
6	14	0.375
8	16	0.375
10	18	0.375
12	20	0.375
14	24	0.375
16	26	0.500
18	30	0.500
20	32	0.500
24	36	0.625
30	42	0.625
36	48	0.750
42	56	0.875

Both ends of the casing shall be mortared. Metal "spider" pipe alignment devices shall be installed in all casings with a minimum of two “spiders” per pipe joint one fourth of the pipe joint length in from both the bell and spigot ends. See Detail W-40.

m. Irrigation Rain Sensors

Irrigation rain sensors are devices mounted in an open outdoor area at least five feet from any structure and wired to the common wire of all permanent in ground irrigation systems. Rain sensors shall be capable of overriding the irrigation controller when 1/4” of rainfall has occurred to keep the system from watering in the rain. Rain sensors shall also be UL listed and installed per the manufacturer’s recommendations.

n. Irrigation Programmable Controllers

Irrigation programmable controllers are devices installed on all permanent in ground irrigation systems that operate the watering cycle of an irrigation system. Controllers shall be programmable by day of the week and UL listed.

WATER CONSTRUCTION STANDARDS (Public and Private Systems)

As part of the requirement to obtain construction approval for water main extensions, the engineer shall affix the appropriate permit sticker to the original drawings. The various permit stickers are included in appendix D.

The requirements contained in this section shall apply to water main installations constructed for the Public Utilities Department or for private developers who may or may not dedicate the water improvements to the City. All necessary construction permits must be obtained before construction may begin in accordance with North Carolina State Law.

Any Contractor performing work within the City of Raleigh or City of Raleigh Merger Areas such as Garner, Knightdale, Wendell, Zebulon, Wake Forest, and Rolesville, shall have on each job site a copy of these specifications.

1. SCOPE OF WORK

- a. The contractor shall furnish all materials, equipment, and labor for excavation, installation, backfilling of water mains and related appurtenances as shown on the plans. The Public Works Department and/or Public Utilities Department shall conduct all City inspections on main extension projects.
- b. It shall be the contractor's responsibility to notify the Public Utilities and Public Works Departments at least twenty-four hours in advance of beginning any construction work on any project. The contractor must call the Public Utilities Department at 996-4540 and Public Works at 996-6810 and give the location, project name, individual's name, company name, start date and indicate if it involves water extensions.
- c. Contractor shall contact the Public Works department at 996-6810 by 4:15 PM each day to notify where and what will be done the following day. For any work conducted in Garner, Knightdale, Wendell, Zebulon, Wake Forest, and Rolesville or outside the City of Raleigh Service Area the contractor shall contact the Public Utilities Department at 996-4540 by 4:15 PM to notify where and what will be done the following day. Any work requiring inspector observation outside of the normal workday, Monday-Friday, 7:30 a.m. to 4:15 p.m. will be charged to the contractor at the current inspector hourly rate.
- d. If a developer, engineer or contractor proceeds with the main installation prior to permit issuance the City may require the work to be reinstalled and the developer, engineer or contractor shall be fully liable for all actions and costs, including prosecution by the City or the State for proceeding with installation prior to issuance of appropriate permit(s).
- e. "Field changes" are not considered approved by the Public Utilities Department unless revised plans have been submitted to the Public Utilities Department, reviewed and approved. Therefore, the contractor that proceeds with construction prior to this approval, is at his/her own risk.
- f. Contractors working (excavation, boring, or other subsurface breach) around or in the vicinity of existing water lines 12 inches in diameter or larger shall be required to physically spot the existing line to be verified by P.U.D. distribution staff or inspection staff. If other existing lines sizes are in question of conflict the contractor shall be directed by P.U.D. staff of the level of subsurface investigation needed to locate the existing line.

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2. GENERAL TESTING REQUIREMENTS

The City may perform and shall require the contractor to perform, such destructive and nondestructive testing, as it deems necessary in order to inspect the materials and workmanship. These tests shall be in accordance with the procedures established by ASTM and AASHTO. The City shall reserve the right to modify the procedures in testing ditch and backfill compaction to allow a deeper test to be made by using the sand-core method and/or nuclear testing gauges.

3. HANDLING AND STORAGE OF MATERIALS

- a. The contractor shall be responsible for the shipping and storing of all water materials. The contractor shall replace any material which is damaged or defective.
- b. The loading and unloading of all pipe, valves, hydrants, and other accessories shall be in accordance with the manufacturer's recommended practices and shall at all times be performed with care to avoid any damage to the material.
- c. The contractor shall locate and provide the necessary storage areas for materials and equipment. If private property is being used for storage areas, then the contractor must have the written consent from the owner. Without this written consent, all material and equipment shall be stored within the existing rights-of-way and easements of the project. Pipe may not be prestrung along job site; it must be delivered to and removed from job site each day. In extenuating circumstances when the inspector authorizes pipe to remain on the project from one day to the next, the ends of the pipe must be sealed.
- d. All materials, once on the job site, shall be stored in accordance with the manufacturer's recommendations.
- e. All pipes shall be kept free of dirt and other debris. Any damage relating to the coating of the various materials for water mains shall be repaired in a manner approved by the City.
- f. The contractor shall be responsible for safeguarding and protecting all material and equipment stored on the job site. The contractor shall be responsible for the storage of materials in a safe and workmanlike manner to prevent injuries, during and after working hours, until the project is complete.

4. BARRICADES, SIGNS AND STREET PROVISIONS

- a. Signs, barricades, warning lights, guard rails and flaggers shall be employed as necessary when construction endangers either vehicular or pedestrian traffic. These devices shall remain in place until the traffic may proceed normally again. The contractor shall hold the City harmless for any damages or injuries caused by the construction of water mains.
- b. Detours and all traffic control measures shall be set up and maintained by the contractor under the direction of the City of Raleigh Department of Transportation and the North Carolina Department of Transportation. Notice must be given a week in advance of the detour so that necessary notification of the traveling public may be made. The contractor will furnish all barricades, signs, lights and other safety devices to protect his/her construction. The contractor is in no way relieved of liability for providing this protection because others approve the detour.

- c. Construction work zone signs and signing procedures shall conform to the MUTCD and supplements and to all applicable federal, state and local codes. The contractor shall be responsible for securing the necessary permits from the City's and the State's Department of Transportation and Inspections for all work to be performed in the public rights-of-way.

5. PROPERTY PROTECTION

Trees, fences, poles and all other property shall be protected unless their removal is authorized, and any property not authorized for removal, but damaged by the contractor, shall be restored by the contractor to the owner's satisfaction.

6. GENERAL CONSTRUCTION SAFETY

- a. The contractor and any subcontractors shall be responsible for the total compliance with all federal, state and local ordinances, laws and regulations as related to safe construction practices and to protecting the employees and the public's health and safety.
- b. The contractor shall ensure that all Occupational Safety and Health Administration (OSHA) regulations and standards are followed during all phases of the construction project.
- c. The City shall not be responsible for the contractor's adherence to OSHA regulations and standards. However, the City may report known violations or unsafe practices to the appropriate enforcement agency.
- d. The contractor shall be required to furnish safety equipment necessary to inspect the work including, but not limited to ladders, gas detectors/oxygen sensors, blowers, etc.

7. ENCROACHMENT CONTRACTS AND PERMITS

- a. Prior to actual construction, the contractor shall acquire the necessary encroachments from NCDOT when working within the rights-of-way of state system roads or highways. The encroachment permit shall be kept on the job site at all times.
- b. The contractor shall be responsible for securing all other local, state and federal permits required for the utility construction.
- c. The contractor must have an approved set of permitted construction plans on site at all times.
- d. For projects which require construction plan approval, all environmental permits and NCDOT encroachments must be provided prior to plan approval. See general policies and regulations section Page 25.

8. PAVEMENT REMOVAL AND REPLACEMENT

- a. All pavements to be removed shall be cut along straight lines with the appropriate saw cut machine. The removal and replacement of the pavement shall conform to the information shown in Details W-1 & W-2.

- b. All cuts of City streets must be patched the same day with a temporary or permanent patch. Once work has been completed, all temporary patches shall be replaced with permanent ones. All work from patching shall be cleaned up at the same time of patching.
- c. The City of Raleigh shall perform density tests as needed to determine contractor's compactive efforts. See Note 2 and 3 of detail W-2.
- d. Pavement cuts shall be confined to a maximum trench bottom width as shown in Details W-1 thru W-3, plus 12 inches on either side.
- e. Asphalt compaction shall be done with a gasoline or diesel powered smooth drum asphaltic roller.
- f. Pavement cuts within NCDOT Right of Way shall not be performed without the proper encroachment permits on site. All patching of NCDOT pavements shall conform to the approved on site encroachment permit.

9. VALVE OPERATIONS

- a. No valve in the existing system shall be operated without following the procedure outlined below. Failure to comply with these requirements shall be grounds for suspension of pipe-laying operations until written assurance can be obtained from a company official that such noncompliance will not occur again. The contractor should be aware that the City regards violations of these requirements as justifying punitive measures.
- b. Notification procedures are as follows:
 - 1) The contractor shall notify the Public Utilities Department's Water Distribution Division at 996-2737 in order to request the operation of any valves. At least twenty-four hours notice must be given to the Public Utilities Department, and at least twenty-four hours notice must be given to each customer affected by a water cut-off. The contractor is responsible for notifying the affected customers. All valve operations shall be done by Public Utilities Department personnel or by the City's inspector for a particular project. It is illegal for anyone other than a City of Raleigh employee to operate an existing water main valve, unless accompanied by a City of Raleigh employee.
 - 2) The contractor shall provide the following information when calling the Water Distribution Division for valve operation:
 - (a) Name of person calling;
 - (b) Name of company;
 - (c) Telephone number of company;
 - (d) Location of valve and map number if available;
 - (e) Reason for requesting operating and whether to be closed or open;
 - (f) Time valve to be opened or closed, and
 - (g) Approximate time water line to be out of service.
- c. Each time a contractor needs a valve operated, he/she shall again secure permission, following the steps outlined.

- d. System valves shall be defined as any valve, which has main pressure against either gate face. Newly installed tapping valves and control valves to networks not yet accepted for service are considered as system valves and should only be operated under guidance of City of Raleigh Inspectors Valves within a network still under construction are not considered as system valves.
- e. All newly installed system valves that connect to the active distribution system shall have a valve box cover painted "red" in color and installed on the corresponding valve box to signify that the valve and main are not in service. The "red" valve box cover shall remain in place until the new main is placed into service, when at such time it shall be replaced with a cover as shown on detail W-18.

10. EXCAVATION

- a. Prior to any excavation or construction, the contractor shall locate all existing utilities in the field. If help is needed in locating utilities operated by the Public Utilities Department, the contractor should contact the Operations Division (996-2737).
- b. Trench width shall be a minimum of twelve inches plus outside diameter of pipe and a maximum of twenty-four inches plus outside diameter of pipe, unless OSHA requires additional trench width. Trench width shall be measured between the faces of the cut at the top elevation of the pipe bell as shown in Detail W-3.
- c. Trench bottom conformation, where no special bedding is required, may be that referred to herein as flat bottom where the trench bottom is excavated slightly above grade and cut down to pipe grade by hand in the fine-grading operation. Where the trench bottom is inadvertently cut below grade, it shall be filled to grade with an approved material and thoroughly compacted to 95% or use #67 stone to bring to grade.
- d. The maximum length of open trench shall be no more than three hundred feet, unless approval is obtained from the Public Utilities Director.
- e. The contractor shall, at his/her own expense, keep all trenches free from water during the excavation for construction of foundations, masonry, water mains. The water shall be pumped out of the trench or check dams shall be built to keep it out of the ditch in such a manner as not to cause injury to the public health, private property or the work in progress. Erosion control measures shall be utilized during this pumping.
- f. In trenches where water is present or dewatering is required, the trench shall be stabilized with #67 stone. When the contractor encounters material during trench excavation, at the opinion of the inspector, or Public Utilities Director, that is unsuitable (i.e. "muck"), this material shall be replaced with material that is considered suitable prior to the pipe laying operations. In this case, construction fabrics may be required to prevent the migration of side support away from the pipe.
- g. Safety and convenience of the public necessitate that all work, including excavation, be done in such a manner as to cause minimum traffic interruption, both pedestrian and vehicular. Utilities such as fire hydrants, valves, etc., shall be accessible at all times. Gutters and drains shall be left open and clear at all times, and the contractor shall be responsible for all drainage around his work. Unless specifically waived by the Public Works Department, provisions shall be made to maintain vehicular traffic on all streets in which work is in progress, and suitable walkways shall be maintained for pedestrian travel.

- h. Sheeting or bracing shall be used wherever necessary to prevent failure of the trench banks. All sheeting shall conform to AASHTO and OSHA safety standards. The decision of the Public Utilities Director or Engineer relative to bracing for the protection of property of the City shall be binding upon the contractor. The removal of sheeting shall be done in such a manner as to minimize the loss of friction between the backfill and trench walls.

11. ROCK EXCAVATION

- a. Rock shall be defined as that solid material that cannot be excavated, in the opinion of the Public Utilities Director or Engineer, by any means other than drilling and blasting, drilling and wedging, or boulders and broken concrete exceeding ½ cubic yard in volume. Rock shall be excavated to the same limits as earth excavation except that the trench shall be made 6- inches lower than the outer bottom of the pipe. This 6-inches shall be refilled with 6-inches of #67 stone and thoroughly compacted to the sub-grade level. All blasting shall be done under the supervision of the City Inspector or Engineer and subject to all applicable regulations. The City reserves the right to require the removal of rock by means other than blasting where any pipe or conduit is either too close to or so situated with respect to the blasting as to make blasting hazardous. Rock taken from the ditch shall immediately be hauled away and disposed of by the contractor.
- b. Blasting procedures shall conform to all applicable local, state and federal laws and ordinances. A blasting permit shall be obtained from the City of Raleigh Fire Marshal's Office, prior to any blasting. The application shall be obtained 24-hours before any blasting takes place, and the Fire Marshal may specify the hours of blasting. The contractor shall take all necessary precautions to protect life and property, including the use of an approved blasting mat where there exists the danger of throwing rock or overburden. The contractor shall keep explosive materials that are on the job site in special constructed boxes provided with locks. Failure to comply with this specification shall be grounds for suspension of blasting operations until full compliance is made. No blasting shall be allowed unless a galvanometer is employed to check cap circuits. Where blasting takes place within five-hundred feet of a utility, structure or property which could be damaged by vibration, concussion or falling rock, the contractor shall be required to take seismograph readings and to keep a blasting log containing the following information for each and every shot.
 - 1) Date of shot
 - 2) Time of shot
 - 3) Crew Supervisor
 - 4) Number and depth of holes
 - 5) Approximate depth of overburden
 - 6) Amount and type of explosive used in each hole
 - 7) Type of caps used (instant or delay)
 - 8) The weather
 - 9) Seismograph instrument and readings
- c. This blasting log shall be made available to the Public Utilities Director or Engineer upon request and shall be kept in an orderly manner. It shall be the contractor's responsibility to have adequate insurance to cover any damages resulting from blasting so to hold the City of Raleigh harmless from any claims.

12. TRENCH PREPARATION

- a. Trench excavation shall conform to the line and depth shown on the plans. The trench shall be properly braced and drained so that workers may work therein safely and efficiently. When water is being pumped from the trench, the pump discharge shall follow natural drainage channels, drains or storm sewers. In discharging trench water, it will be necessary to follow standard erosion control measures so as to minimize erosion and sedimentation. In no case may trench water or groundwater be pumped into or allowed to enter the sanitary sewer system.
- b. The width of the trench may vary with the depth of cut and other conditions the trench shall be in accordance with the dimensions set forth by OSHA and other information shown on Detail W-3.
- c. The foundations for ductile iron shall be a firm and stable flat bottom (Type 1) trench with bell holes so that the pipe rests uniformly on the entire barrel length. See Detail W-3.
- d. Pipe clearance in rock shall be a minimum of six inches below and on each side of the pipe for sized sixteen inches and less in diameter. For sizes larger than sixteen inches in diameter, the minimum clearance shall be nine inches below and on each side.

13. PIPE INSTALLATION

- a. Ductile iron pipe shall be installed in accordance with the requirements of AWWA Standard C-600.
- b. Water pipe shall be laid to the line and grade shown on the plans with all valves and hydrants located as shown on the plans.
- c. Protection shall be afforded to all underground and surface structures using methods acceptable to the Public Utilities Director or Engineer. This protection shall be furnished by the contractor at the contractors' own expense.
- d. Deviation from line and grade may be made only on revised plans upon approval by Public Utilities Department and identified on "as built" when such deviations arise from grade or line conflicts with existing utilities, structures or other sources of conflict.
- e. Subsurface explorations shall be made by the contractor at the direction of the Public Utilities Director or Engineer where it is necessary to determine the location of existing pipes, valves or other underground structures.
- f. Depth of pipe cover, unless shown otherwise on the plans shall be three feet above top of pipe. Depth of cover shall be measured from the established street grade or the surface of the permanent improvement to the top of the barrel of the pipe. **If minimum cover cannot be maintained due to other agency/development infrastructure projects existing water lines shall be relocated or protected with casings or concrete. In no case shall sub grade construction excavations come within less than 2 feet of the existing pipe crown.**
- g. After the foundation has been properly graded, bedded when applicable, and the bell holes dug, the pipe and accessories shall be carefully lowered into the trench by approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe and accessories shall be removed from the job.

- h. Pipe interior shall be swabbed clean with sodium hypochlorite solution before it is laid, and any pipe which cannot be cleaned with a swab shall be removed and cleaned with suitable apparatus. Any pipe showing evidence of oil, tar or grease shall be permanently marked and removed from the job.
- i. Laying of pipe and jointing of pipe shall be done according to manufacturer's recommendation with care being taken to provide uniform bearing for the pipe. Bell and spigot of pipe shall be cleaned and properly lubricated where a mechanical joint of a "push on" type joint is employed. No chlorine powder or tablets shall be put in the lines during installation.
- j. Open ends of pipe shall be plugged with a standard plug or cap at all times when pipe laying is not in progress. Trench water shall not be permitted to enter pipe.
- k. Pipe cutting for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner in accordance with the manufacturer's recommendations and without damage to the pipe.
- l. Bell ends will face the direction of laying unless otherwise directed by the Public Utilities Director or Engineer. For lines on an appreciable slope, the Public Utilities Director or Engineer may also require that bell ends face upgrade.
- m. Maximum horizontal deflections for ductile iron pipe shall be as follows for an eighteen foot joint of pipe:

Maximum Deflection in Inches		
Pipe Size	Mech. Joint	Push-on-joint
6	27	19
8	20	19
10	20	19
12	20	19
14	13	11
16	13	11
18	11	11
20	11	11
24	9	11
30	9	11
36	8	11
42	7	7
48	7	7

- n. When installing water &/or sewer mains, the horizontal separation between utilities shall be 10'. If this separation cannot be maintained due to existing conditions, the variation allowed is the water main in a separate trench with the elevation of the water main at least 18" above the top of the sewer & must be approved by the Public Utilities Director. All distances are measured from outside diameter to outside diameter

Where it is impossible to obtain proper separation, or anytime a sanitary sewer passes over a water main, DIP materials or steel encasement extended 10' on each side of crossing must be specified & installed to waterline specifications

Maintain 18" min. vertical separation at all water main & RCP storm drain crossings; Where adequate separations cannot be achieved, specify DIP materials & a concrete cradle having 6" min. clearance (per CORPUD detail W-41)

All other underground utilities shall cross water & sewer facilities with 18" min. vertical separation required

- o. Maintain 18" min. vertical separation at all water main & storm drain crossings. Where adequate separations cannot be achieved, specify DIP materials & a concrete cradle having 6" min. clearance (per COR PUD details W-41.)
- p. All other underground utilities shall cross water & sewer facilities with 18" min. vertical separation required
- q. Railroad crossings shall be made following all precautionary construction measures required by the railroad officials.
- r. All water crossings under the state system roads shall be made in accordance with the requirements of the NC DOT as defined in their encroachment permits.
- s. Where conditions are, in the opinion of the City Inspector unsuitable for laying pipe because of weather or trench conditions, the contractor shall be required to cease work until permission is given by the City Inspector for work to commence again providing such conditions have been corrected.

14. REACTION BLOCKING

- a. All fittings or components subject to hydrostatic thrust shall be securely anchored by the use of concrete thrust blocks poured in place, unless otherwise directed by the engineer. The reaction areas required for these thrust blocks shall be given to the contractor by the inspector, and the contractor shall install the blocks according to directions provided by the inspector. Where concrete must be reinforced, the contractor shall furnish such reinforcing as is required.
- b. Required reaction bearing areas will be taken from the schedule herein. See Details W-10 & W-11. Areas given are vertical plans measured in solid material normal to the thrust line of the fitting.
- c. Material for reaction blocking shall be transit-mixed concrete. This concrete shall have a twenty-eight day compressive strength of 3000 psi. Any metal used to resist thrust which is not encased in concrete shall be "hot dipped" galvanized.
- d. Valves on ductile iron lines shall be anchored with thrust collars as shown in Details W-7 thru W-9.

15. BACKFILLING PIPE

- a. The backfilling of the trench after the pipe installation and testing shall be in accordance with Details W-3 for ductile iron.

Ductile iron pipe shall be backfilled with suitable native material. No rocks, boulders or stone four inches or larger shall be included in the backfill for at least two feet above the top of the pipe.

- b. All backfill shall be compacted in six-inch lifts measured from the pipe foundation upward. Backfill for roadway shall be compacted to at least 95% of maximum soil density in those areas where the supporting capacity of the soil is of prime consideration. Laboratory determination of maximum soil density will follow the procedure of AASHTO T99-86. Field determination of the density of the soil in place shall follow the procedure of AASHTO T191-86 or T204-86. The result of any one test may be a minimum of 90% of maximum density, but the average of any three tests in an area shall be 95% of maximum density. All tests shall be conducted at the direction of the City Inspector, and the cost of such tests will be borne by the contractor with the provision that the City will test an area two times only where both tests fail. The contractor shall then be required to submit satisfactory evidence that his ditch compaction meets the specifications.
- c. Deficiency of backfill material shall be supplied by the contractor where this deficiency results from any cause other than rejection of unsuitable backfill material (other than rock) by the City Inspector. In cases where the City Inspector directs, the contractor shall dispose of unsuitable backfill material and provide suitable backfill material.

Where excavated material has been rendered unsuitable, either before or after excavation, by inclement weather or type of material, the contractor must correct the moisture or furnish replacement backfill material.

- d. Backfilling shall not be allowed, except with permission of the City Inspector. When a ditch is flooded or the weather is unsuitable, the contractor shall not backfill unless permission is given by the City Inspector. No backfilling with frozen material shall be allowed.

16. SETTING VALVES AND VALVE BOXES

- a. Valves shall be set at locations shown on the plans with care being taken to support the valve properly and to accurately position the valve box over the operating nut of the valve. Where pavement exists, the box shall be adjusted to finished street grade and a concrete pad two-feet square and six inches thick shall be poured around the box two inches from the top of finished grade as shown in Detail W-17. When valves are located in street rights-of-way, but out of pavement, the boxes shall be adjusted to finished grade and a concrete pad two-feet square and six-inches thick shall be poured around the box one-half inch from the top. When valves are located outside of street rights-of-way, the boxes shall be at finish grade, and a concrete block two-feet square and six-inches thick shall be poured around the box at grade line. Valve locations out of street rights-of-way shall be marked with a metal post having a minimum diameter of two inches and a minimum bury of three feet with a minimum of three feet exposed. The exposed portion shall be painted bright orange and shall be placed so that a valve operating tool has free operation.
- b. When a tapping sleeve and valve are being used, the valve, sleeve and machine assembly shall be air tested to hold at 150 psi for a five-minute duration in the presence of the inspector prior to drilling or tapping the main. All tap coupons shall be given to the city inspector. The valve shall be in the closed position during the testing.

- c. Reverse taps are not permitted unless approved by the Public Utilities Director. They must have sufficient cover and be marked with a 4 inch PVC marker at the tapping valve identified with an "R" designation.

17. SETTING FITTINGS

Fittings shall be set at locations shown on the plans with care being taken to properly "bell-up" joints and support the body of the fitting. All dead-end lines shall be plugged with mechanical joint plugs or caps and anchored by using thrust collars and blocking as shown on Details W-7 thru W-12.

18. SETTING HYDRANTS

- a. Specific directions are required for the setting of all hydrants. In streets where paving is proposed in the near future, the contractor will be given line and grade stakes for hydrants. It is mandatory for the contractor to preserve these stakes for the inspector to verify that the hydrant was set correctly. In areas where paving is not anticipated in the near future, hydrants shall be set according to the inspector's directions. When fire hydrants are installed behind guard rails breakaway flanges shall be installed at the ground level and flush with the top of the guard rail. In these installations where multiple barrel extensions are required the fire hydrant stems shall be a single one piece unit. In general, hydrants shall be located in a manner to provide complete accessibility and minimize possibility of damage from vehicles or injury to pedestrians.
- b. Hydrant installation shall be as shown in Detail W-4 and shall be restrained from the main to the hydrant with a mechanical joint pipe restraining system. If the distance is greater than 20 feet the hydrant branch shall be restrained for the entire length with a mechanical joint pipe restraining system. When hydrants are used as blow-off assemblies, the valves shall be rodded to a thrust block. Restraining rods and accessories shall be "hot dipped" galvanized. Detail W-4A is another available option.
- c. Before a hydrant is set, all dirt and foreign matter shall be removed from the interior of the hydrant.
- d. Hydrants shall be bagged to indicate "out of service" until all testing is complete and the mains are placed in service. Bags shall be large enough to cover the entire hydrant and shall be black in color. Bags shall be secured with duct tape at the base of the hydrant and shall be removed immediately after the hydrants are placed in service.

19. SETTING BLOW-OFFS AND RELEASE VALVES

- a. Blow-offs and drainage branches shall not be connected to any sewer, submerged in any stream, or be installed in any other manner that will permit back siphonage into the distribution system.
- b. All air release valves and blow-offs shall be installed as shown on Details W-19 - W-22. Air release valves must be such that provisions can be made by the contractor to get the flow of water to a natural drainage way.

20. SURFACE RESTORATION

- a. All disturbed surfaces and property thereon, shall be restored to a condition equal to that existing before construction began, and the contractor shall maintain and be responsible for all ditches in paved streets, curbs, gutters or sidewalks until the contractor repaves the trench cuts. The contractor, with permission of the inspector, may place temporary or permanent asphaltic material in the cut. Asphalt compaction shall be done with a gasoline or diesel powered smooth drum asphaltic roller.
- b. All easements will be seeded with grass and left so they can be mowed by conventional mowers, unless approved by the Public Utilities Department for rip-rap or other specified material. In remote areas, easements will be seeded with a quality fescue grass. In residential areas, easements will be seeded with either falcon or rebel fescue or leaf mulch at the request of property owner. The contractor shall guarantee a good uniform stand of grass and shall reseed any bare or thin spots. The contractor will be responsible for a one-year warranty on materials and workmanship.

21. EROSION CONTROL

Erosion control measures shall be performed by the contractor, conforming to the requirements of, and in accordance with plans approved by the State of North Carolina Department of Environment and Natural Resources, North Carolina Sedimentation Control Commission and City of Raleigh Inspections Department Erosion Control Division, and as per the erosion control plan portion of the construction drawings and these specifications. The sedimentation and erosion control plan and permit shall remain on site at all times. The contractor shall not allow mud and debris to accumulate in the streets. Should the contractor pump water from trenches during construction, appropriate siltation preventative measures shall be taken prior to the entry into any storm drain or stream. All measures must be taken so that stormwater runoff does not go to the pipes or manholes of the utility system. All materials used for erosion control shall be approved by the Engineer prior to installation by the contractor.

- a. Temporary and permanent erosion control measures shall be shown on the plans. Temporary and permanent erosion control work shall be coordinated throughout the project to provide effective and continuous erosion control throughout construction and post construction, which minimizes siltation of streams, lakes, reservoirs, other water impoundments, ground surface, or other property. Seeding and mulching shall be carried out immediately behind construction.
- b. Temporary erosion control measures shall include but not be limited to swales in the easements, silt fences, crushed stone check dam devices, silt basins (sedimentation traps), mulching, earth berms, and rip-rap.
- c. Permanent erosion control measures shall include but not be limited to swales in the easements, rip rap and seeding of disturbed areas.
- d. Erosion and siltation shall be controlled on projects by using swales to control run-off and convey run-off to controlled discharge points, by silt fences, rip-rap, crushed stone, and earth berms to contain silt, with pipe culverts where major access or haul roads cross drainage ditches or streams, silt basins where pipe lines cross drainage ditches or streams, and seeding and mulching will be performed as soon after pipe installation as possible. When temporary measures are removed after completion of the project the disturbed area must be stabilized, if necessary.

22. MAINTAINING SERVICE

When replacing or extending water mains the contractor shall maintain continuous water service to all existing residences and businesses.

23. GUARANTEE

The contractor shall guarantee all material, equipment and workmanship for a period of at least one-year after final acceptance by the City. The Public Works Department Construction Inspection Division is responsible for the issuance of final acceptance letters by the City.

For projects in Merger Areas the Public Utilities Department Construction Inspection Division is responsible for issuance of final acceptance letters.

24. WETLAND/STREAM BUFFERS

Conditions of 401/404 permits shall be strictly followed to the satisfaction of Corps of Engineers. All Neuse Riparian buffers shall be maintained as required by the North Carolina Division of Water Quality.

25. GENERAL WATER MAIN TESTING SEQUENCE

Water mains shall be tested in the following general sequence:

- a) "Pigging" main (mains with gate valves)
- b) Flush the main (all flush water shall be de-chlorinated using methods acceptable to the City of Raleigh Public Utilities Department);
- c) Perform the hydrostatic tests;
- d) Introduce the appropriate amount of chlorine by tapping the main;
- e) Hold the chlorine solution in the main for at least twenty-four hours and no more than seventy-two hours;
- f) Flush the main (all flush water shall be de-chlorinated using methods acceptable to the City of Raleigh Public Utilities Department);
- g) Sample for the bacteriological tests; and
- h) Water mains shall be placed into service within 48 hours of meeting bacteriological analysis requirements. If no activity is anticipated on a water main for the first 30 days after it is placed into service, the contractor shall notify the City of Raleigh Public Utilities Department at 870-2870 and provide the location and permit number.

26. PIGGING

All new mains with gate valves must be pigged with a polyethylene "pig", 5#/cubic foot density at the conclusion of installation.

The pig must be blown at the end of the main by means of the following:

- a) 4" main - 4" blow-off (private only)
- b) 6" main - fire hydrant or 6" blow-off
- c) 8" and 12" through blow-off assembly as on Details W-21 & W-22
- d) 16" – 24" As determined by the field inspector

The contractor installing the line shall write the name of the company and street name in which the work is taking place on the pig in a manner in which it will not rub off.

27. HYDROSTATIC TESTS

- a. All main installations including private distribution and fire lines to the buildings shall be pressure tested between each main line valve in accordance with AWWA C-600. The test shall be performed using a suitable pump and an accurate pressure gauge. Immediately upon completion of a section of main, 150 psi (\pm 5 psi) of pressure shall be applied and held for two hours. Fire lines shall be tested at 200 psi. The acceptable leakage rate shall not exceed .092 gallons per inch of pipe diameter per 1,000 feet of pipe per hour.

Failure of the water main to comply with the above acceptable leakage rate, shall require the contractor to replace any defective materials to insure a watertight installation. If it is deemed that the existing blow-off valve is the cause of failure, the party responsible for the water main extension shall also be responsible for adding a valve at that location and abandoning the existing valve. After any inadequacies have been corrected, the leakage rate will again be tested. This test shall be repeated until that portion of main is brought to compliance with the permissible leakage rate.

- b. Prerequisite conditions for inspection prior to testing shall be as follows:
 - 1) Hydrants shall be properly located, operable, plumb and at correct elevation.
 - 2) Valves shall be properly located, operable and at correct elevation. Valve boxes or manholes shall be centered over operating nuts, and the top of the box or manhole shall be at proper elevation.
 - 3) Lines shall be properly vented where entrapped air is a consideration.

28. CHLORINATION

- a. All additions or replacements to the water system, including fire lines and backflow prevention devices, shall be chlorinated before being placed in service. Such chlorination must take place under the supervision of an inspector.
- b. Pipe subjected to contaminating materials shall be treated as directed by the Public Utilities Department or Engineer. Should such treatment fail to cleanse the pipe, replacement shall be required. The City shall bear no portion of any cost sustained by the contractor in meeting this specification.
- c. Chlorination of a completed line shall be carried out after completing the pressure test and in the following manner.

- 1) Taps will be made at the control valve at the upstream end of the line and at all extremities of the line including valves. These taps shall be located in such a manner as to allow HTH solution to be fed into all parts of the line.
- 2) A solution of water containing high test hypochlorite (70%) available chlorine or chlorine gas solution shall be introduced into the line by regulated pumping at the control valve tap. The solution shall be of such a concentration that the line shall have a uniform concentration of 50 ppm total chlorine immediately after chlorination. The chart below shows the required quantity of 70% HTH compound to be contained in solution in each 1000-foot section of line to produce the desired concentration of 50 ppm.

Pipe Size	Pounds of high Test Hypochlorite (70%) Per 1000' of Line
6"	.88
8"	1.56
10"	2.42
12"	3.50
14"	4.76
16"	6.22
20"	9.76
24"	14.00
30"	21.00
36"	31.50
48"	56.00

- 3) The HTH solution shall be circulated in the main by opening the control valve and systematically manipulating hydrants and taps at the line extremities. The HTH solution must be pumped in at a constant rate for each discharge rate in order that a uniform concentration will be produced in the mains.
- 4) Services shall be sterilized by methods acceptable to the Public Utilities Director or Engineer, and the contractor shall have the same responsibility for laterals as for mains in regard to bearing full cost of any corrective measures needed to comply with bacteriological or other requirements.
- 5) HTH solution shall remain in lines for no less than twenty-four hours, unless otherwise directed by the Public Utilities Director or Engineer.
- 5) Extreme care will be exercised at all times to prevent the HTH solution from entering existing mains.

29. BACTERIOLOGICAL SAMPLING

- a. Free residual chlorine after twenty-four hours shall be at least 10 ppm, or the Public Utilities Department or Engineer will require the lines be re-chlorinated.
- b. Mains will be flushed with a blow-off assembly of sufficient size to effectively clean the main. Detail W-22. Flushing of lines may proceed after twenty-four hours, provided the free residual chlorine analysis is satisfactory. Flushing shall be continued until chlorine returns to normal level. In times of water shortages or distribution main problems, the flushing operation may be delayed. The Public Utilities Department shall determine when flushing is allowable. The contractor shall advise the inspector prior to the chlorination and flushing so that the inspector can advise the Public Utilities Department of the construction location, size and length of mains. All tests will be done in the presence of an inspector. Flushing will be for short duration. Sufficient precautions must be taken to the satisfaction of the inspector to ensure that the impact of the water is absorbed and the water is conveyed without erosion or property drainage. All flush water shall be de-chlorinated using methods acceptable to the City of Raleigh Public Utilities Department.
- c. After flushing is completed, the Public Works Department or Public Utilities Department Inspector shall collect samples for turbidity and bacteriological analysis for each section of pipe between main line valves. Sample point locations shall be determined by a representative of the engineer or owner. A custody seal shall be placed on each set of turbidity and bacteriological bottles. A chain of custody form must be completed for sample set(s) collected and must be delivered along with the sample(s). A turbidity test will be done. If the turbidity exceeds 1 NTU, the sample fails and a bacteriological test will not be set up. The Public Utilities Department will perform the turbidity and bacteriological analysis.
- d. Samples will be accepted between 8:00 AM and 12 NOON and 1PM and 3:30 PM Monday through Thursday, excluding holidays. Special arrangements may be made for samples to be accepted outside of this time frame by calling the laboratory in advance.
- e. In the event that two successive bacteriologic tests fail, that section of the main shall be re-chlorinated by the contractor and new tests performed prior to moving to the next section of main.

30. SERVICE CONNECTIONS

- a. Taps shall be made only on a line under pressure and after the main has been tested and chlorinated. No taps on dry lines shall be allowed, unless specific authorization from the **Public Utilities Department** is obtained.
- b. Taps shall be at an angle of forty-five degrees to a perpendicular plane through the center line of the pipe as shown is in Detail W-23.
- c. The maximum size of a direct tap shall be 1" for mains 6" and larger. Larger taps may be made by using a service saddle.
- d. Services larger than two inches shall be made by using a tapping sleeve and valve. Service size shall match tap size.

The typical tapping sleeve and valve is shown in Standard Detail W-14.