

PROJECT MANUAL

Bid Documents
Delaware Technical and Community
College Automotive Center of Excellence
EDA PROJECT #01-01-14801
Georgetown, Delaware

Volume I
DIVISION 00 THROUGH DIVISION 05



ARCHITECTURE
ENGINEERING

Becker Morgan Group, Inc.
312 West Main Street, Suite 300
Salisbury, Maryland 21801

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DTCC AUTOMOTIVE CENTER OF EXCELLENCE

Delaware Technical and Community College, Owens Campus
Georgetown, Delaware

ADVERTISEMENT FOR BIDS

Separate sealed bids for the construction of DTCC Automotive Center of Excellence shall be accepted until **3:00 PM local time on August 1, 2019**, at which time bids will be publicly opened and read aloud. Sealed bids shall be delivered to Building 400, Corporate Training Center, Chabbott Center, Room 401, Delaware Technical and Community College Terry Campus, 100 Campus Drive, Dover, DE 19904. The project consists of a new approximately 13,500 square foot pre-engineered building and associated site work.

Contract documents may be examined at the offices of Becker Morgan Group, Inc., 309 South Governors Avenue, Dover, Delaware and 312 West Main Street, Suite 300, Salisbury, Maryland 21801 and at DiCarlo Precision Instrument, Inc., 2006 Northwood Drive, Salisbury, Maryland 21801.

Copies of the Bid Documents will be available for examination and order after **2:00 PM local time, on July 8, 2019**. Full sets and partial sets of Bid Documents are available directly from DiCarlo Precision Instrument, Inc., 2006 Northwood Drive, Salisbury, Maryland 21801 at no charge. Addenda will be issued electronically and only to bidders or subcontractors who obtained full sets of the Bid Documents. Owner and Architect are not responsible for bidders and/or subcontractors not obtaining the information provided through the full set of bid documents.

A pre-bid meeting for all contractors will be held in Room 604, Trades and Industries Center, Delaware Technical and Community College Owens Campus, 21265 Technology Drive, Georgetown, DE on **July 16, 2019 at 10:00 AM local time**. Attendance is strongly recommended.

No Bidder may withdraw their bid within sixty (60) days after the date and time of bid opening. Delaware Technical and Community College may extend the time and place for the opening of bids by facsimile notification to those general contract bidders who have obtained full sets of Bid Documents through DiCarlo Precision Instrument, Inc.

By the order of Delaware Technical and Community College, Mr. Gerald M. McNesby, Vice President for Finance.

SECTION 001200 - INVITATION TO BIDDERS

1. Sealed bids for the DTCC Automotive Center of Excellence will be received until **3:00 PM local time on August 1, 2019 at Building 400, Corporate Training Center, Chabbott Center, Room 401, Delaware Technical and Community College Terry Campus, 100 Campus Drive, Dover, DE 19904.** A Delaware Business License is required for both contractors and subcontractors at the time of bid.
2. A Pre-Bid Meeting will be on **July 16, 2019 at 10:AM** local time in Room 604, Trades and Industries Center, Delaware Technical and Community College Owens Campus, 21265 Technology Drive, Georgetown, DE. Attendance is strongly recommended.
3. Contract documents may be examined at the offices of Becker Morgan Group, Inc., 309 South Governors Avenue, Dover, Delaware and 312 West Main Street, Suite 300, Salisbury, Maryland 21801 and at DiCarlo Precision Instrument, Inc., 2006 Northwood Drive, Salisbury, Maryland 21801. Copies of the Bid Documents will be available for examination and order after 2:00 PM local time, on July 8, 2019. Full sets and partial sets of Bid Documents are available directly from DiCarlo Precision Instrument, Inc., 2006 Northwood Drive, Salisbury, Maryland 21801 at no charge. Addenda will be issued electronically and only to bidders or subcontractors who obtained full sets of the Bid Documents. Owner and Architect are not responsible for bidders and/or subcontractors not obtaining the information provided through the full set of bid documents.
4. Each Bid must be submitted in a sealed envelope, addressed to Delaware Technical and Community College. Each sealed envelope containing a Bid must be plainly marked on the outside, as DTCC Automotive Center of Excellence Project, and the envelope should bear on the outside the Bidder's name and address. If forwarded by mail, the sealed envelope containing the Bid must be enclosed in another envelope addressed as indicated above.
5. All Bids must be made on the required Bid Form. All blank spaces for Bid prices must be filled in, in ink or typewritten, and the Bid Form must be fully completed and executed when submitted. Only one (1) copy of the Bid Form is required. A conditional or qualified Bid will not be accepted.
6. Bidders must satisfy themselves of the accuracy of the estimated quantities in the Bid schedule by examination of the site and review of the drawings and specifications including Addenda. After Bids have been submitted, the Bidder shall not assert that there was a misunderstanding concerning the quantities of Work or of the nature of the Work to be done. Each Bidder is responsible for inspecting the site and for reading and being thoroughly familiar with the Contract Documents. The failure or omission of any Bidder to do any of the foregoing shall in no way relieve any Bidder from any obligation in respect to its Bid.
7. Each Bid must be accompanied by a 5% Bid Bond payable to the Owner for the total amount of the Bid. When the Agreement is executed the bonds of the unsuccessful Bidders will be returned. The Bid Bond of the successful Bidder will be retained until the payment Bond and performance Bond have been executed and approved, after which it will be returned. The form of the Bid Bond shall be AIA Document A310-1970 Bid Bond or equivalent. A certified check may be used in lieu of a Bid Bond.
8. A Performance Bond and Labor and Material Payment Bond in the full amount of the contract award will be required by the successful bidder prior to the execution of the contract. The form of the bonds shall be AIA Document A312-1984.

9. It is the intention of the Owner to award a Contract to the lowest qualified bidder whose bid is determined to be the most advantageous to the Owner considering price, experience with this type of work, compliance with bidding qualifications, construction schedule and other submissions in accordance with the requirements of the Bidding Documents and does not exceed available funds. The Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's own best interest. The Owner intends to execute the contract for the full project using AIA A101-2017 *Standard Form of Agreement Between Owner and Contractor* with an Owner Amendment.

10. It is the intention of the Owner to award a Contract to the bidder whose Proposal best meets the following Criteria:

A. Cost. It is the intent of the owner to award a contract to the lowest qualified bidder who best meets the goals as described above and whose bid is determined to be the most advantageous to the Owner considering price, experience with this type of work, compliance with bidding qualifications, construction schedule and other submission in accordance with the requirements of the Bidding Documents and does not exceed available funds.

B. Other Criteria. Proposals will be evaluated on the following:

- * Fully completed and Executed Bid From
- * Required Bid & performance bonds
- * Experience with Project Type (provide on AIA form A305 to be included w/bid form)
- * References (provide on AIA form A305 to be included w/bid form)
- * Overall Proposed Construction Schedule
- * Full compliance that all project program elements meet ADA standards and regulations as defined by the US Department of Justice 2010 ADA standards for Accessible Design, DOT ADA standard 201 and DOT ADA regulation 49 C.F.R. 37.43 (A) (1)

The Owner intends to execute the contract for the full project using AIA A101-2017 *Standard Form of Agreement Between Owner and Contractor* with an Owner Amendment.

11. Certified Minority Business Enterprises are encouraged to respond to this solicitation notice. Refer to the "Notice of requirements for affirmative action to ensure equal employment opportunity (executive order 11246 and 41 cfr part 60-4) form included in section 004343 of the project manual.

12. Attention is called to provisions for minimum wages (State of Delaware and Davis-Bacon Act). Bidders should base their labor rates on the most recent published. Attention is also called to other Federally mandated clauses in the Supplementary General Conditions.

13. Attention is called to the Federal Clean Water Clause. Bidders are to read and review this clause which is included in section 003000 of the project manual. The signatory area of the clause must be signed and completed as part of the bid form.

14. The Owner may waive any informalities or minor defects or reject any and all Bids. Any Bid may be withdrawn prior to the above scheduled time for the opening of Bids or authorized postponement thereof. Any Bid received after the time and date specified shall not be considered. No Bidder may withdraw a Bid within sixty (60) days after the actual date of the opening thereof. Should there be

reasons why the contract cannot be awarded within the specified period; the time may be extended by mutual agreement between the Owner and the Bidder.

15. The Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the obligations of the Agreement and to complete the Work contemplated therein.
16. The party to whom the contract is awarded will be required to execute the Agreement and obtain the Performance Bond and Payment Bond with ten (10) calendar days from the date when Notice of Award is delivered to the Bidder. In case of failure of the Bidder to execute the Agreement, the Owner may consider the Bidder in default, in which case the Bid Bond accompanying the proposal shall become the Property of the Owner.
17. The Owner, within ten (10) days of receipt of acceptable Performance Bond and Payment Bond and Agreement signed by the party to whom the Agreement was awarded shall sign the Agreement and return to such party an executed duplicate of the Agreement. Should the Owner not execute the Agreement within such period, the Bidder may by written notice withdraw the signed Agreement. Such notice of withdrawal shall be effective upon receipt of the notice by the Owner.
18. The Notice to Proceed shall be issued within fifteen (15) days of the execution of the Agreement by the Owner. Should there be reasons why the Notice to Proceed cannot be issued within such period; the time may be extended by mutual agreement between the Owner and Contractor.
19. The Contract Documents contain the provisions required for the construction of the Project. Information obtained from an officer, agent, or employee of the Owner or any other person shall not affect the risks or obligations assumed by the Contractor or relieve the contractor from fulfilling any of the conditions of the contract.
20. All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the Project shall apply to the contract throughout.
21. Owner: Delaware Technical and Community College. Owner's Representative and Primary Contact: Mark DeVore, Collegewide Director of Facilities Delaware Technical Community College, 100 Campus Drive, Dover, DE 19904, Dover, Delaware, Phone: 302.857.1654.
22. Architect: Becker Morgan Group, Inc., 312 West Main Street, Suite 300, Salisbury, MD, 21801. Phone: 410.546.9100. Architect's Representatives: Ellis F. Hammond, AIA.
23. Bidders shall examine the Bid Documents carefully and shall promptly notify the Architect of any ambiguity, inconsistency or error, which they may discover. All work reasonably inferable or required to provide a complete and usable facility is to be included in the bid.
24. Bidders requiring clarification, interpretation, or correction, of the bidding documents, shall make a **written** request by the Architect. Direct requests to **Attn: Ellis F. Hammond, Becker Morgan Group Architects at ehammond@beckermorgan.com**. Deadline for any questions will be received by the Architect until 2:00 PM local time, 7 business days prior to the bid-due date or the question cut-off date, whichever is earlier. Phone calls and verbal requests for interpretation will not be accepted.
25. Any interpretation, correction or change of the Bid Documents will be made by Addendum only. Interpretations, corrections, or changes of the Bid Documents made in any other manner will not be

binding, and Bidders shall not rely upon such interpretations, corrections, and changes. **Addenda will be issued electronically directly from DiCarlo Precision Instrument, Inc.**, 2006 Northwood Drive, Salisbury, Maryland 21801, and only to bidders or subcontractors who obtained full sets of the Bid Documents. Bidders are responsible to ensure receipt of any and all addendums by notifying DiCarlo Precision Instrument, Inc.

26. Federal Participation Disclosure-This project will be partially funded with Federal funds from the United States Department of Commerce, Economic Development Administration and therefore is subject to the Federal laws and regulations associated with that program.
27. Provisions for Liquidated Damages as defined in the Supplementary General Conditions apply to this contract.
28. Note: The contractor and all subcontractors are required to maintain the insurances outlined in the EDA contracting provisions for construction projects (line item 13) contained in section 008000 of the project manual. Dollar values of insurances are required to meet the State of Delaware minimums.

By the order of Delaware Technical and Community College, Mr. Gerald M. McNesby, Vice President for Finance.

END OF INVITATION AND INSTRUCTIONS TO BIDDERS

DRAFT AIA® Document A701™ - 1997

Instructions to Bidders

for the following PROJECT:

(Name and location or address)

«AIA - Blank Documents»

« »

THE OWNER:

(Name, legal status and address)

« »« »

« »

THE ARCHITECT:

(Name, legal status and address)

« »« »

« »

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ADDITIONS AND DELETIONS:

The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

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ARTICLE 1 DEFINITIONS

§ 1.1 Bidding Documents include the Bidding Requirements and the proposed Contract Documents. The Bidding Requirements consist of the Advertisement or Invitation to Bid, Instructions to Bidders, Supplementary Instructions to Bidders, the bid form, and other sample bidding and contract forms. The proposed Contract Documents consist of the form of Agreement between the Owner and Contractor, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications and all Addenda issued prior to execution of the Contract.

§ 1.2 Definitions set forth in the General Conditions of the Contract for Construction, AIA Document A201, or in other Contract Documents are applicable to the Bidding Documents.

§ 1.3 Addenda are written or graphic instruments issued by the Architect prior to the execution of the Contract which modify or interpret the Bidding Documents by additions, deletions, clarifications or corrections.

§ 1.4 A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

§ 1.5 The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents as the base, to which Work may be added or from which Work may be deleted for sums stated in Alternate Bids.

§ 1.6 An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from the amount of the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.

§ 1.7 A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment or services or a portion of the Work as described in the Bidding Documents.

§ 1.8 A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

§ 1.9 A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment or labor for a portion of the Work.

ARTICLE 2 BIDDER'S REPRESENTATIONS

§ 2.1 The Bidder by making a Bid represents that:

§ 2.1.1 The Bidder has read and understands the Bidding Documents or Contract Documents, to the extent that such documentation relates to the Work for which the Bid is submitted, and for other portions of the Project, if any, being bid concurrently or presently under construction.

§ 2.1.2 The Bid is made in compliance with the Bidding Documents.

§ 2.1.3 The Bidder has visited the site, become familiar with local conditions under which the Work is to be performed and has correlated the Bidder's personal observations with the requirements of the proposed Contract Documents.

§ 2.1.4 The Bid is based upon the materials, equipment and systems required by the Bidding Documents without exception.

ARTICLE 3 BIDDING DOCUMENTS

§ 3.1 COPIES

§ 3.1.1 Bidders may obtain complete sets of the Bidding Documents from the issuing office designated in the Advertisement or Invitation to Bid in the number and for the deposit sum, if any, stated therein. The deposit will be refunded to Bidders who submit a bona fide Bid and return the Bidding Documents in good condition within ten days after receipt of Bids. The cost of replacement of missing or damaged documents will be deducted from the deposit. A Bidder receiving a Contract award may retain the Bidding Documents and the Bidder's deposit will be refunded.

§ 3.1.2 Bidding Documents will not be issued directly to Sub-bidders unless specifically offered in the Advertisement or Invitation to Bid, or in supplementary instructions to bidders.

§ 3.1.3 Bidders shall use complete sets of Bidding Documents in preparing Bids; neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

§ 3.1.4 The Owner and Architect may make copies of the Bidding Documents available on the above terms for the purpose of obtaining Bids on the Work. No license or grant of use is conferred by issuance of copies of the Bidding Documents.

§ 3.2 INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS

§ 3.2.1 The Bidder shall carefully study and compare the Bidding Documents with each other, and with other work being bid concurrently or presently under construction to the extent that it relates to the Work for which the Bid is submitted, shall examine the site and local conditions, and shall at once report to the Architect errors, inconsistencies or ambiguities discovered.

§ 3.2.2 Bidders and Sub-bidders requiring clarification or interpretation of the Bidding Documents shall make a written request which shall reach the Architect at least seven days prior to the date for receipt of Bids.

§ 3.2.3 Interpretations, corrections and changes of the Bidding Documents will be made by Addendum. Interpretations, corrections and changes of the Bidding Documents made in any other manner will not be binding, and Bidders shall not rely upon them.

§ 3.3 SUBSTITUTIONS

§ 3.3.1 The materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution.

§ 3.3.2 No substitution will be considered prior to receipt of Bids unless written request for approval has been received by the Architect at least ten days prior to the date for receipt of Bids. Such requests shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitution including drawings, performance and test data, and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other portions of the Work, including changes in the work of other contracts that incorporation of the proposed substitution would require, shall be included. The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

§ 3.3.3 If the Architect approves a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approvals made in any other manner.

§ 3.3.4 No substitutions will be considered after the Contract award unless specifically provided for in the Contract Documents.

§ 3.4 ADDENDA

§ 3.4.1 Addenda will be transmitted to all who are known by the issuing office to have received a complete set of Bidding Documents.

§ 3.4.2 Copies of Addenda will be made available for inspection wherever Bidding Documents are on file for that purpose.

§ 3.4.3 Addenda will be issued no later than four days prior to the date for receipt of Bids except an Addendum withdrawing the request for Bids or one which includes postponement of the date for receipt of Bids.

§ 3.4.4 Each Bidder shall ascertain prior to submitting a Bid that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.

ARTICLE 4 BIDDING PROCEDURES

§ 4.1 PREPARATION OF BIDS

§ 4.1.1 Bids shall be submitted on the forms included with the Bidding Documents.

§ 4.1.2 All blanks on the bid form shall be legibly executed in a non-erasable medium.

§ 4.1.3 Sums shall be expressed in both words and figures. In case of discrepancy, the amount written in words shall govern.

§ 4.1.4 Interlineations, alterations and erasures must be initialed by the signer of the Bid.

§ 4.1.5 All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change."

§ 4.1.6 Where two or more Bids for designated portions of the Work have been requested, the Bidder may, without forfeiture of the bid security, state the Bidder's refusal to accept award of less than the combination of Bids stipulated by the Bidder. The Bidder shall make no additional stipulations on the bid form nor qualify the Bid in any other manner.

§ 4.1.7 Each copy of the Bid shall state the legal name of the Bidder and the nature of legal form of the Bidder. The Bidder shall provide evidence of legal authority to perform within the jurisdiction of the Work. Each copy shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further give the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current power of attorney attached certifying the agent's authority to bind the Bidder.

§ 4.2 BID SECURITY

§ 4.2.1 Each Bid shall be accompanied by a bid security in the form and amount required if so stipulated in the Instructions to Bidders. The Bidder pledges to enter into a Contract with the Owner on the terms stated in the Bid and will, if required, furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Should the Bidder refuse to enter into such Contract or fail to furnish such bonds if required, the amount of the bid security shall be forfeited to the Owner as liquidated damages, not as a penalty. The amount of the bid security shall not be forfeited to the Owner in the event the Owner fails to comply with Section 6.2.

§ 4.2.2 If a surety bond is required, it shall be written on AIA Document A310, Bid Bond, unless otherwise provided in the Bidding Documents, and the attorney-in-fact who executes the bond on behalf of the surety shall affix to the bond a certified and current copy of the power of attorney.

§ 4.2.3 The Owner will have the right to retain the bid security of Bidders to whom an award is being considered until either (a) the Contract has been executed and bonds, if required, have been furnished, or (b) the specified time has elapsed so that Bids may be withdrawn or (c) all Bids have been rejected.

§ 4.3 SUBMISSION OF BIDS

§ 4.3.1 All copies of the Bid, the bid security, if any, and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the party receiving the Bids and shall be identified with the Project name, the Bidder's name and address and, if applicable, the designated portion of the Work for which the Bid is submitted. If the Bid is sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.

§ 4.3.2 Bids shall be deposited at the designated location prior to the time and date for receipt of Bids. Bids received after the time and date for receipt of Bids will be returned unopened.

§ 4.3.3 The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids.

§ 4.3.4 Oral, telephonic, telegraphic, facsimile or other electronically transmitted bids will not be considered.

§ 4.4 MODIFICATION OR WITHDRAWAL OF BID

§ 4.4.1 A Bid may not be modified, withdrawn or canceled by the Bidder during the stipulated time period following the time and date designated for the receipt of Bids, and each Bidder so agrees in submitting a Bid.

§ 4.4.2 Prior to the time and date designated for receipt of Bids, a Bid submitted may be modified or withdrawn by notice to the party receiving Bids at the place designated for receipt of Bids. Such notice shall be in writing over the signature of the Bidder. Written confirmation over the signature of the Bidder shall be received, and date- and time-stamped by the receiving party on or before the date and time set for receipt of Bids. A change shall be so worded as not to reveal the amount of the original Bid.

§ 4.4.3 Withdrawn Bids may be resubmitted up to the date and time designated for the receipt of Bids provided that they are then fully in conformance with these Instructions to Bidders.

§ 4.4.4 Bid security, if required, shall be in an amount sufficient for the Bid as resubmitted.

ARTICLE 5 CONSIDERATION OF BIDS

§ 5.1 OPENING OF BIDS

At the discretion of the Owner, if stipulated in the Advertisement or Invitation to Bid, the properly identified Bids received on time will be publicly opened and will be read aloud. An abstract of the Bids may be made available to Bidders.

§ 5.2 REJECTION OF BIDS

The Owner shall have the right to reject any or all Bids. A Bid not accompanied by a required bid security or by other data required by the Bidding Documents, or a Bid which is in any way incomplete or irregular is subject to rejection.

§ 5.3 ACCEPTANCE OF BID (AWARD)

§ 5.3.1 It is the intent of the Owner to award a Contract to the lowest qualified Bidder provided the Bid has been submitted in accordance with the requirements of the Bidding Documents and does not exceed the funds available. The Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's own best interests.

§ 5.3.2 The Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided in the Bidding Documents, and to determine the low Bidder on the basis of the sum of the Base Bid and Alternates accepted.

ARTICLE 6 POST-BID INFORMATION

§ 6.1 CONTRACTOR'S QUALIFICATION STATEMENT

Bidders to whom award of a Contract is under consideration shall submit to the Architect, upon request, a properly executed AIA Document A305, Contractor's Qualification Statement, unless such a Statement has been previously required and submitted as a prerequisite to the issuance of Bidding Documents.

§ 6.2 OWNER'S FINANCIAL CAPABILITY

The Owner shall, at the request of the Bidder to whom award of a Contract is under consideration and no later than seven days prior to the expiration of the time for withdrawal of Bids, furnish to the Bidder reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract. Unless such reasonable evidence is furnished, the Bidder will not be required to execute the Agreement between the Owner and Contractor.

§ 6.3 SUBMITTALS

§ 6.3.1 The Bidder shall, as soon as practicable or as stipulated in the Bidding Documents, after notification of selection for the award of a Contract, furnish to the Owner through the Architect in writing:

- .1 a designation of the Work to be performed with the Bidder's own forces;
- .2 names of the manufacturers, products, and the suppliers of principal items or systems of materials and equipment proposed for the Work; and
- .3 names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work.

§ 6.3.2 The Bidder will be required to establish to the satisfaction of the Architect and Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.

§ 6.3.3 Prior to the execution of the Contract, the Architect will notify the Bidder in writing if either the Owner or Architect, after due investigation, has reasonable objection to a person or entity proposed by the Bidder. If the Owner or Architect has reasonable objection to a proposed person or entity, the Bidder may, at the Bidder's option, (1) withdraw the Bid or (2) submit an acceptable substitute person or entity with an adjustment in the Base Bid or Alternate Bid to cover the difference in cost occasioned by such substitution. The Owner may accept the adjusted bid price or disqualify the Bidder. In the event of either withdrawal or disqualification, bid security will not be forfeited.

§ 6.3.4 Persons and entities proposed by the Bidder and to whom the Owner and Architect have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and Architect.

ARTICLE 7 PERFORMANCE BOND AND PAYMENT BOND

§ 7.1 BOND REQUIREMENTS

§ 7.1.1 If stipulated in the Bidding Documents, the Bidder shall furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Bonds may be secured through the Bidder's usual sources.

§ 7.1.2 If the furnishing of such bonds is stipulated in the Bidding Documents, the cost shall be included in the Bid. If the furnishing of such bonds is required after receipt of bids and before execution of the Contract, the cost of such bonds shall be added to the Bid in determining the Contract Sum.

§ 7.1.3 If the Owner requires that bonds be secured from other than the Bidder's usual sources, changes in cost will be adjusted as provided in the Contract Documents.

§ 7.2 TIME OF DELIVERY AND FORM OF BONDS

§ 7.2.1 The Bidder shall deliver the required bonds to the Owner not later than three days following the date of execution of the Contract. If the Work is to be commenced prior thereto in response to a letter of intent, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered in accordance with this Section 7.2.1.

§ 7.2.2 Unless otherwise provided, the bonds shall be written on AIA Document A312, Performance Bond and Payment Bond. Both bonds shall be written in the amount of the Contract Sum.

§ 7.2.3 The bonds shall be dated on or after the date of the Contract.

§ 7.2.4 The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of the power of attorney.

ARTICLE 8 FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR

Unless otherwise required in the Bidding Documents, the Agreement for the Work will be written on AIA Document A101, Standard Form of Agreement Between Owner and Contractor Where the Basis of Payment Is a Stipulated Sum.

ATTACHMENT TO AIA DOCUMENT A701-1997, *Instructions to Bidders*

The provisions of this Attachment shall delete, modify and supplement the provisions contained in the "*Instructions to Bidders*," AIA Document A701-1997 Edition. The provisions contained in this Attachment will supersede any conflicting provisions of the AIA Document. The term "Agency," as used in this Attachment, shall mean the United States of America, acting through the United States Department of Agriculture.

ARTICLE 2, BIDDER'S REPRESENTATIONS

2.1 Add the following subparagraph to paragraph 2.1:

2.1.5 This Bid has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this Bid, with any other Bidder or with any competitor.

ARTICLE 4, BIDDING PROCEDURES

4.1.1 Add the following sentence to subparagraph 4.1.1:

Only one copy of the Bid is to be submitted.

4.2.1 Delete subparagraph 4.2.1 and substitute the following:

4.2.1 Each Bid must be accompanied by a Bid Bond payable to the Owner for five percent of the total amount of the Bid.

4.2.2 Delete Subparagraph 4.2.2 and substitute the following:

4.2.2 The Bid Bond shall be written on a form identical to that included in the Bidding Documents, and the attorney-in-fact who executes the Bid Bond on behalf of the surety shall affix to the Bid Bond a certified and current copy of the power of attorney.

4.2.3 Add the words "payment and performance" before the word "bonds"; and add the following to subparagraph 4.2.3:

As soon as the Bid prices have been compared, the Owner will return the Bid Bonds of all except the three lowest responsible Bidders. When the Agreement is executed, the Bid Bonds of the two remaining unsuccessful Bidders will be returned.

4.2 Add the following subparagraph to paragraph 4.2:

4.2.4 If a Bidder refuses to execute the Agreement or obtain the Performance and Payment Bonds within the agreed time, the Owner may consider the Bidder in default, in which case the Bid Bond accompanying the Bid shall become the property of the Owner.

4.3 Add the following subparagraphs to paragraph 4.3:

4.3.5 All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the Project, shall apply to the Contract throughout.

4.3.6 The Bidder agrees to abide by the requirements of Executive Order 11246, specifically including the provisions of the Equal Opportunity Clause and the Standard Federal Equal Employment Construction Contract Specifications set forth in the Supplementary Conditions.

4.3.7 The Bidder agrees to abide by the requirements of section 319 of Public Law 101-121, which pertains to lobbying activities and applies to recipients of contracts or subcontracts that exceed \$100,000 at any tier under a Federal loan that exceeds \$150,000 or a Federal grant that exceeds \$100,000. Each Bid shall be accompanied by a completed lobbying certification form identical to that included in the Bidding Documents.

4.3.8 The Bidder agrees to abide by the requirements under 7 C.F.R. part 3017, which pertains to the debarment or suspension of a person from participating in a Federal program or activity. Each Bid exceeding \$25,000 shall be accompanied by a relevant completed certification form identical to that included in the Bidding Documents.

4.4.1 Delete subparagraph 4.4.1 and substitute the following:

4.4.1 No Bidder may withdraw, modify or cancel a Bid within 60 calendar days after the actual date of the opening thereof. Should there be reasons why the Contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the Owner and the Bidder, and the concurrence of the Agency.

4.4.4 Delete the words ", if required," from Subparagraph 4.4.4.

ARTICLE 5, CONSIDERATION OF BIDS

5.3.2 Delete subparagraph 5.3.2 and substitute the following:

5.3.2 The Owner shall have the right to accept Alternates in the sequence or combinations listed and to determine the low Bidder on the basis of the sum of the Base Bid and the Alternates accepted.

ARTICLE 7, PERFORMANCE BOND AND PAYMENT BOND

7.1.1 Delete subparagraph 7.1.1 and substitute the following:

7.1.1 Prior to execution of the Contract, the Bidder shall furnish Bonds covering the faithful performance of the Contract and the payment of all obligations arising thereunder. Both Bonds shall be separately written, each in the amount of the Contract Sum. The cost shall be included in the Bid.

7.1.2 Delete subparagraph 7.1.2 and substitute the following:

7.1.2 Surety companies executing Bonds must hold a certificate of authority as a acceptable surety on Federal Bonds as listed in Treasury Circular 570, as amended, and be authorized to transact business in the State where the Project is located.

7.1.3 Delete subparagraph 7.1.3.

7.2.1 Delete subparagraph 7.2.1 and substitute the following:

7.2.1 The Bidder to whom the Contract is awarded will be required to execute the Agreement and obtain Performance and Payment Bonds within ten (10) calendar days from the date when the Notice of Award is delivered to the Bidder. The Notice shall be accompanied by the necessary Agreement and Bond forms.

7.2.2 Delete subparagraph 7.2.2 and substitute the following:

7.2.2 The Bonds shall be written on forms identical to those included in the Bidding Documents.

(Note: Any additional provisions that are necessary to remain effective after execution of the Contract for Construction will be inserted here and continue in the same format.)

oOo

BID FORM

TO: Mr. Gerald M. McNesby, Vice President for Finance,
Delaware Technical & Community College
100 Campus Drive
Dover, DE 19904

RE: **DTCC Automotive Center of Excellence**
21265 Technology Drive
Georgetown, Delaware 19947

The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER on the form included in the Contract Documents to complete all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the Contract Documents.

BIDDER has examined the site and locality where the Work is to be performed, the legal requirements (federal, state and local laws, ordinances, rules and regulations) and the conditions affecting cost, progress or performance of the Work and has made such independent investigations as BIDDER seems necessary.

I/We agree to achieve total project substantial completion of the work within _____ calendar days (**not to exceed 455 days**) of the notice to proceed date. A construction schedule documenting this will be required to be submitted in accordance with Section 013200 Construction Progress Documentation.

Receipt of the following addenda to the drawings and specifications is hereby acknowledged:

Addendum No. _____ Dated _____ Addendum No. _____ Dated _____

Addendum No. _____ Dated _____ Addendum No. _____ Dated _____

BASE BID (Stipulated Lump Sum):

The sum of _____ Dollars, (\$ _____)

ALTERNATES:

A. DEDUCT ALTERNATE ONE – REDUCE HEIGHT OF SIX OVERHEAD DOORS

1. BASE BID: Provide specified 18' high overhead doors at six locations noted on drawings.
2. ALTERNATE: In lieu of 18' high overhead doors, provide 12' high overhead doors at six locations noted on drawings.

Deduct _____ dollars and _____ cents (\$ _____).

B. DEDUCT ALTERNATE TWO – FRP IN TOILET ROOMS

1. BASE BID: Provide specified FRP in Women 111 and Men 112.
2. ALTERNATE: In lieu of FRP, provide abuse resistant drywall in Women 111 and Men 112.

Deduct _____ dollars and _____ cents (\$ _____).

C. DEDUCT ALTERNATE THREE – SKYLIGHTS

1. BASE BID: Provide skylights as specified and shown on drawings.
2. ALTERNATE: Provide no skylights.

Deduct _____ dollars and _____ cents (\$_____).

D. DEDUCT ALTERNATE FOUR – CHARGING STATIONS

1. BASE BID: Provide two charging stations as noted on drawings.
2. ALTERNATE: In lieu of two charging stations, provide only conduit for two future charging stations as noted on drawings.

Deduct _____ dollars and _____ cents (\$_____).

E. DEDUCT ALTERNATE FIVE – PARKING SPACES

1. BASE BID: Provide parking as designated on drawings.
2. DEDUCT ALTERNATE “A”: Of the total number of parking spaces, provide seventeen parking spaces, surfaced with crusher run, as designated on drawings.

Deduct _____ dollars and _____ cents (\$_____).

3. ALTERNATE “B”: Eliminate seventeen parking spaces, as designated on drawings.

Deduct _____ dollars and _____ cents (\$_____).

F. DEDUCT ALTERNATE SIX – ROOF PANEL TYPES

1. BASE BID: Provide Foamed-Insulation-Core Standing Seam Roof Panels as specified.
2. ALTERNATE: In lieu of Foamed-Insulation-Core Standing Seam Roof Panels, provide Standing Seam Roof Panels with batt insulation.

Deduct _____ dollars and _____ cents (\$_____).

BIDDER hereby agrees to furnish all labor, materials, equipment and services required for the project.

LIST OF SUBCONTRACTORS:

Bidders must complete Section 004150 - Subcontractor Listing for this project at time of bid. Upon award of the Contract, the General Contractor must supply a completed AIA G705-2001, List of Subcontractors.

UNIT PRICES:

1. Unit Price No. 1 – Excavation and removal of unsuitable material from site with furnishing and placing select backfill including compaction and all other incidental work. Measurement and payment will be made for quantities actually excavated, removed, furnished and placed. Unsuitable soil will be defined by the testing agency as specified in Section 312000 Earth Moving. Allow 500 CY of removal of unsuitable materials and replacement with select within base bid.

_____ Dollars per cubic yard (\$_____ /cy)

In submitting this bid we agree:

1. This offer is binding and cannot be withdrawn until sixty (60) days from date of Bid.
2. To accept the provisions of Instructions to Bidders.
3. To enter into and execute a contract, if awarded on the basis of this Bid, and to furnish performance and payment bonds in accordance with the Instructions to Bidders and Supplementary Conditions.
4. To accomplish the Work in accordance with the Contract Documents.
5. Owner will award based on review of lowest responsive and responsible bidder based on alternates, submitted proposed substantial completion date and bidder's qualification.
6. All subcontractors or suppliers furnishing over \$100,000 in combined labor and material are bondable.
7. Add/Alternate pricing to be held for one hundred twenty (120) days from date of Bid.
8. This bid is based upon minimum wage rates designated by the state of Delaware and the Davis Bacon Act.

Owner will review base bids from responsive bidders, submitted proposed substantial completion dates and bidders' qualifications. Owner will make the award based on his best interests.

We have attached the required bid security to this bid.

(1) Signature when Bidder is an individual:

Respectfully submitted,

Date

Firm Name

Owner

(2) Signature when Bidder is a partnership:

Date

Firm Name

Signature of Partner

Signature of Partner

Signature of Partner

(3) Signature when Bidder is a Corporation:

Date

Firm Name

By _____

Corporate Seal

Title

NON-COLLUSION STATEMENT

The Bidder hereby attests that neither he nor she nor anyone on his or her behalf have conspired with any other party in an attempt to bid a fixed or set price.

Signed: _____

Title: _____

WITNESS:

SUBSCRIBED AND SWORN to, and before me, a Notary Public,

of the State of _____

County of/City of _____

Signed: _____

Title: _____ Notary Public _____

This _____ day of _____, 2019

Delaware Contractor's License # _____

Federal EI # _____

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BUY AMERICA CERTIFICATION

Contractor is to complete one of the sections below and submit with their bid.

Certificate of Compliance with 49 U.S.C. 5323(j)(1)

The bidder or offeror hereby certifies that it will meet the requirements of 49 U.S.C. 5323(j)(1) and the applicable regulations in 49 C.F.R. Part 661.5.

Date _____

Signature _____

Company Name _____

Title _____

or

Certificate of Non-Compliance with 49 U.S.C. 5323(j)(1)

The bidder or offeror hereby certifies that it cannot comply with the requirements of 49 U.S.C. 5323(j)(1) and 49 C.F.R. 661.5, but it may qualify for an exception pursuant to 49 U.S.C. 5323(j)(2)(A), 5323(j)(2)(B), or 5323(j)(2)(D), and 49 C.F.R. 661.7.

Date _____

Signature _____

Company Name _____

Title _____

CERTIFICATION REGARDING LOBBYING

APPENDIX A, 49 CFR PART 20

Certification for Contracts, Grants, Loans, and Cooperative Agreements
(To be submitted with each bid or offer exceeding \$100,000)

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for making lobbying contacts to an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form--LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions [as amended by "Government wide Guidance for New Restrictions on Lobbying," 61 Fed. Reg. 1413 (1/19/96). Note: Language in paragraph (2) herein has been modified in accordance with Section 10 of the Lobbying Disclosure Act of 1995 (P.L. 104-65, to be codified at 2 U.S.C. 1601, *et seq.*)]
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31, U.S.C. § 1352 (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

[Note: Pursuant to 31 U.S.C. § 1352(c)(1)-(2)(A), any person who makes a prohibited expenditure or fails to file or amend a required certification or disclosure form shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such expenditure or failure.]

The Contractor, _____, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. A 3801, *et seq.*, apply to this certification and disclosure, if any.

_____ Signature of Contractor's Authorized Official

_____ Name and Title of Contractor's Authorized Official

_____ Date

**CERTIFICATION REGARDING PROJECT MANUAL SECTION 008000-Supplementary
General Conditions**

The Contractor, _____, certifies or affirms that they have read and accepted all clauses and conditions noted in project manual section 008000 – “Supplementary General Conditions”

_____ Signature of Contractor's Authorized Official

_____ Name and Title of Contractor's Authorized Official

_____ Date

CERTIFICATION REGARDING FTA Clauses

The Contractor, _____, certifies or affirms that they have read and accepted all applicable FTA clauses including but not limited to the Clean Water Federal Clause which is attached at the end of project manual section 003000.

_____ Signature of Contractor's Authorized Official

_____ Name and Title of Contractor's Authorized Official

_____ Date

PROJECT EXPERIENCE & REFERENCES

Provide a completed AIA form A305 “Qualification Statement” (see attached blank below) along with your bid form.

DRAFT AIA® Document A305™ – 1986

Contractor's Qualification Statement

The Undersigned certifies under oath that the information provided herein is true and sufficiently complete so as not to be misleading.

SUBMITTED TO: <>

ADDRESS: <>

SUBMITTED BY: <>

NAME: <>

ADDRESS: <>

PRINCIPAL OFFICE: <>

[<>] Corporation

[<>] Partnership

[<>] Individual

[<>] Joint Venture

[<>] Other <>

NAME OF PROJECT: (if applicable) <>

TYPE OF WORK: (file separate form for each Classification of Work)

[<>] General Construction

[<>] HVAC

[<>] Electrical

[<>] Plumbing

[<>] Other: (Specify) <>

§ 1 ORGANIZATION

§ 1.1 How many years has your organization been in business as a Contractor? <>

§ 1.2 How many years has your organization been in business under its present business name? <>

§ 1.2.1 Under what other or former names has your organization operated?

<>

§ 1.3 If your organization is a corporation, answer the following:

§ 1.3.1 Date of incorporation: <>

§ 1.3.2 State of incorporation: <>

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

This form is approved and recommended by the American Institute of Architects (AIA) and The Associated General Contractors of America (AGC) for use in evaluating the qualifications of contractors. No endorsement of the submitting party or verification of the information is made by AIA or AGC.

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§ 1.3.3 President's name: << >>

§ 1.3.4 Vice-president's name(s)

<< >>

§ 1.3.5 Secretary's name: << >>

§ 1.3.6 Treasurer's name: << >>

§ 1.4 If your organization is a partnership, answer the following:

§ 1.4.1 Date of organization: << >>

§ 1.4.2 Type of partnership (if applicable): << >>

§ 1.4.3 Name(s) of general partner(s)

<< >>

§ 1.5 If your organization is individually owned, answer the following:

§ 1.5.1 Date of organization: << >>

§ 1.5.2 Name of owner:

<< >>

§ 1.6 If the form of your organization is other than those listed above, describe it and name the principals:

<< >>

§ 2 LICENSING

§ 2.1 List jurisdictions and trade categories in which your organization is legally qualified to do business, and indicate registration or license numbers, if applicable.

<< >>

§ 2.2 List jurisdictions in which your organization's partnership or trade name is filed.

<< >>

§ 3 EXPERIENCE

§ 3.1 List the categories of work that your organization normally performs with its own forces.

<< >>

§ 3.2 Claims and Suits. (If the answer to any of the questions below is yes, please attach details.)

§ 3.2.1 Has your organization ever failed to complete any work awarded to it?

<< >>

§ 3.2.2 Are there any judgments, claims, arbitration proceedings or suits pending or outstanding against your organization or its officers?

<< >>

§ 3.2.3 Has your organization filed any law suits or requested arbitration with regard to construction contracts within the last five years?

<< >>

§ 3.3 Within the last five years, has any officer or principal of your organization ever been an officer or principal of another organization when it failed to complete a construction contract? (If the answer is yes, please attach details.)

<< >>

§ 3.4 On a separate sheet, list major construction projects your organization has in progress, giving the name of project, owner, architect, contract amount, percent complete and scheduled completion date.

<< >>

§ 3.4.1 State total worth of work in progress and under contract:

<< >>

§ 3.5 On a separate sheet, list the major projects your organization has completed in the past five years, giving the name of project, owner, architect, contract amount, date of completion and percentage of the cost of the work performed with your own forces.

<< >>

§ 3.5.1 State average annual amount of construction work performed during the past five years:

<< >>

§ 3.6 On a separate sheet, list the construction experience and present commitments of the key individuals of your organization.

<< >>

§ 4 REFERENCES

§ 4.1 Trade References:

<< >>

§ 4.2 Bank References:

<< >>

§ 4.3 Surety:

§ 4.3.1 Name of bonding company:

<< >>

§ 4.3.2 Name and address of agent:

<< >>

§ 5 FINANCING

§ 5.1 Financial Statement.

§ 5.1.1 Attach a financial statement, preferably audited, including your organization's latest balance sheet and income statement showing the following items:

Current Assets (e.g., cash, joint venture accounts, accounts receivable, notes receivable, accrued income, deposits, materials inventory and prepaid expenses);

Net Fixed Assets;

Other Assets;

Current Liabilities (e.g., accounts payable, notes payable, accrued expenses, provision for income taxes, advances, accrued salaries and accrued payroll taxes);

Other Liabilities (e.g., capital, capital stock, authorized and outstanding shares par values, earned surplus and retained earnings).

§ 5.1.2 Name and address of firm preparing attached financial statement, and date thereof:

« »

§ 5.1.3 Is the attached financial statement for the identical organization named on page one?

« »

§ 5.1.4 If not, explain the relationship and financial responsibility of the organization whose financial statement is provided (e.g., parent-subsidiary).

« »

§ 5.2 Will the organization whose financial statement is attached act as guarantor of the contract for construction?

« »

§ 6 SIGNATURE

§ 6.1 Dated at this « » day of « » « »

Name of Organization: « »

By: « »

Title: « »

§ 6.2

« »

M « » being duly sworn deposes and says that the information provided herein is true and sufficiently complete so as not to be misleading.

Subscribed and sworn before me this « » day of « » « »

Notary Public: « »

My Commission Expires: « »

STATE OF DELAWARE
OFFICE OF MANAGEMENT AND BUDGET

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____
_____ of _____ in the County of _____
_____ and State of _____ as **Principal**, and _____
_____ of _____ in the County of _____
and State of _____ as **Surety**, legally authorized to do business in the State of Delaware
("State"), are held and firmly unto the **State** in the sum of _____
_____ Dollars (\$_____), or _____ percent not to exceed _____
_____ Dollars (\$_____)
of amount of bid on Contract No. _____, to be paid to the **State** for the use and
benefit of _____ (*insert State agency name*) for which payment
well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators, and
successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bonded **Principal**
who has submitted to the _____ (*insert State agency name*) a
certain proposal to enter into this contract for the furnishing of certain material and/or services within the
State, shall be awarded this Contract, and if said **Principal** shall well and truly enter into and execute this
Contract as may be required by the terms of this Contract and approved by the _____
_____ (*insert State agency name*) this Contract to be entered into within twenty days after
the date of official notice of the award thereof in accordance with the terms of said proposal, then this
obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____ seal and dated this _____ day of _____ in the year of our Lord two
thousand and _____ (20____).

SEALED, AND DELIVERED IN THE
Presence of

Name of Bidder (Organization)

Corporate
Seal

By:

Authorized Signature

Attest _____

Title

Name of Surety

Witness: _____

By:

Title

NOTICE TO PROCEED

To: _____ DATE: _____

_____ Project: _____

You are hereby notified to commence WORK in accordance with the Agreement dated _____, 201_ on or before _____, 201_, and you are to complete the WORK within _____ consecutive calendar days thereafter. The date of completion of all WORK is therefore _____ 201_____.

Owner

By _____

Title _____

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE TO PROCEED is

hereby acknowledged by _____

This the _____, 201_.

By: _____

Title: _____

Employer Identification Number _____

DRAFT AIA® Document A101™ – 2017

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

AGREEMENT made as of the day of in the year
(In words, indicate day, month and year.)

BETWEEN the Owner:
(Name, legal status, address and other information)

and the Contractor:
(Name, legal status, address and other information)

for the following Project:
(Name, location and detailed description)

The Architect:
(Name, legal status, address and other information)

The Owner and Contractor agree as follows.

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

The parties should complete A101™-2017, Exhibit A, Insurance and Bonds, contemporaneously with this Agreement. AIA Document A201™-2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

ELECTRONIC COPYING of any portion of this AIA® Document to another electronic file is prohibited and constitutes a violation of copyright laws as set forth in the footer of this document.

TABLE OF ARTICLES

- 1 THE CONTRACT DOCUMENTS**
- 2 THE WORK OF THIS CONTRACT**
- 3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION**
- 4 CONTRACT SUM**
- 5 PAYMENTS**
- 6 DISPUTE RESOLUTION**
- 7 TERMINATION OR SUSPENSION**
- 8 MISCELLANEOUS PROVISIONS**
- 9 ENUMERATION OF CONTRACT DOCUMENTS**

EXHIBIT A INSURANCE AND BONDS

ARTICLE 1 THE CONTRACT DOCUMENTS

The Contract Documents consist of this Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement, and Modifications issued after execution of this Agreement, all of which form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. An enumeration of the Contract Documents, other than a Modification, appears in Article 9.

ARTICLE 2 THE WORK OF THIS CONTRACT

The Contractor shall fully execute the Work described in the Contract Documents, except as specifically indicated in the Contract Documents to be the responsibility of others.

ARTICLE 3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

§ 3.1 The date of commencement of the Work shall be:

(Check one of the following boxes.)

- [« »] The date of this Agreement.
- [« »] A date set forth in a notice to proceed issued by the Owner.
- [« »] Established as follows:
(Insert a date or a means to determine the date of commencement of the Work.)

« »

If a date of commencement of the Work is not selected, then the date of commencement shall be the date of this Agreement.

§ 3.2 The Contract Time shall be measured from the date of commencement of the Work.

§ 3.3 Substantial Completion

§ 3.3.1 Subject to adjustments of the Contract Time as provided in the Contract Documents, the Contractor shall achieve Substantial Completion of the entire Work:

(Check one of the following boxes and complete the necessary information.)

- [« »] Not later than « » (« ») calendar days from the date of commencement of the Work.

[« »] By the following date: « »

§ 3.3.2 Subject to adjustments of the Contract Time as provided in the Contract Documents, if portions of the Work are to be completed prior to Substantial Completion of the entire Work, the Contractor shall achieve Substantial Completion of such portions by the following dates:

Portion of Work	Substantial Completion Date

§ 3.3.3 If the Contractor fails to achieve Substantial Completion as provided in this Section 3.3, liquidated damages, if any, shall be assessed as set forth in Section 4.5.

ARTICLE 4 CONTRACT SUM

§ 4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be « » (\$ « »), subject to additions and deductions as provided in the Contract Documents.

§ 4.2 Alternates

§ 4.2.1 Alternates, if any, included in the Contract Sum:

Item	Price

§ 4.2.2 Subject to the conditions noted below, the following alternates may be accepted by the Owner following execution of this Agreement. Upon acceptance, the Owner shall issue a Modification to this Agreement. (Insert below each alternate and the conditions that must be met for the Owner to accept the alternate.)

Item	Price	Conditions for Acceptance

§ 4.3 Allowances, if any, included in the Contract Sum: (Identify each allowance.)

Item	Price

§ 4.4 Unit prices, if any:

(Identify the item and state the unit price and quantity limitations, if any, to which the unit price will be applicable.)

Item	Units and Limitations	Price per Unit (\$0.00)

§ 4.5 Liquidated damages, if any:

(Insert terms and conditions for liquidated damages, if any.)

« »

§ 4.6 Other:

(Insert provisions for bonus or other incentives, if any, that might result in a change to the Contract Sum.)

« »

ARTICLE 5 PAYMENTS

§ 5.1 Progress Payments

§ 5.1.1 Based upon Applications for Payment submitted to the Architect by the Contractor and Certificates for Payment issued by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

§ 5.1.2 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month, or as follows:

« »

§ 5.1.3 Provided that an Application for Payment is received by the Architect not later than the « » day of a month, the Owner shall make payment of the amount certified to the Contractor not later than the « » day of the « » month. If an Application for Payment is received by the Architect after the application date fixed above, payment of the amount certified shall be made by the Owner not later than « » (« ») days after the Architect receives the Application for Payment.

(Federal, state or local laws may require payment within a certain period of time.)

§ 5.1.4 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be prepared in such form, and supported by such data to substantiate its accuracy, as the Architect may require. This schedule of values shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ 5.1.5 Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

§ 5.1.6 In accordance with AIA Document A201™–2017, General Conditions of the Contract for Construction, and subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

§ 5.1.6.1 The amount of each progress payment shall first include:

- .1 That portion of the Contract Sum properly allocable to completed Work;
- .2 That portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction, or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing; and
- .3 That portion of Construction Change Directives that the Architect determines, in the Architect's professional judgment, to be reasonably justified.

§ 5.1.6.2 The amount of each progress payment shall then be reduced by:

- .1 The aggregate of any amounts previously paid by the Owner;
- .2 The amount, if any, for Work that remains uncorrected and for which the Architect has previously withheld a Certificate for Payment as provided in Article 9 of AIA Document A201–2017;
- .3 Any amount for which the Contractor does not intend to pay a Subcontractor or material supplier, unless the Work has been performed by others the Contractor intends to pay;
- .4 For Work performed or defects discovered since the last payment application, any amount for which the Architect may withhold payment, or nullify a Certificate of Payment in whole or in part, as provided in Article 9 of AIA Document A201–2017; and
- .5 Retainage withheld pursuant to Section 5.1.7.

§ 5.1.7 Retainage

§ 5.1.7.1 For each progress payment made prior to Substantial Completion of the Work, the Owner may withhold the following amount, as retainage, from the payment otherwise due:

(Insert a percentage or amount to be withheld as retainage from each Application for Payment. The amount of retainage may be limited by governing law.)

« »

§ 5.1.7.1.1 The following items are not subject to retainage:
(Insert any items not subject to the withholding of retainage, such as general conditions, insurance, etc.)

<< >>

§ 5.1.7.2 Reduction or limitation of retainage, if any, shall be as follows:
(If the retainage established in Section 5.1.7.1 is to be modified prior to Substantial Completion of the entire Work, including modifications for Substantial Completion of portions of the Work as provided in Section 3.3.2, insert provisions for such modifications.)

<< >>

§ 5.1.7.3 Except as set forth in this Section 5.1.7.3, upon Substantial Completion of the Work, the Contractor may submit an Application for Payment that includes the retainage withheld from prior Applications for Payment pursuant to this Section 5.1.7. The Application for Payment submitted at Substantial Completion shall not include retainage as follows:
(Insert any other conditions for release of retainage upon Substantial Completion.)

<< >>

§ 5.1.8 If final completion of the Work is materially delayed through no fault of the Contractor, the Owner shall pay the Contractor any additional amounts in accordance with Article 9 of AIA Document A201–2017.

§ 5.1.9 Except with the Owner’s prior approval, the Contractor shall not make advance payments to suppliers for materials or equipment which have not been delivered and stored at the site.

§ 5.2 Final Payment

§ 5.2.1 Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when

- .1 the Contractor has fully performed the Contract except for the Contractor’s responsibility to correct Work as provided in Article 12 of AIA Document A201–2017, and to satisfy other requirements, if any, which extend beyond final payment; and
- .2 a final Certificate for Payment has been issued by the Architect.

§ 5.2.2 The Owner’s final payment to the Contractor shall be made no later than 30 days after the issuance of the Architect’s final Certificate for Payment, or as follows:

<< >>

§ 5.3 Interest

Payments due and unpaid under the Contract shall bear interest from the date payment is due at the rate stated below, or in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

(Insert rate of interest agreed upon, if any.)

<< >> % << >>

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

The Architect will serve as the Initial Decision Maker pursuant to Article 15 of AIA Document A201–2017, unless the parties appoint below another individual, not a party to this Agreement, to serve as the Initial Decision Maker.

(If the parties mutually agree, insert the name, address and other contact information of the Initial Decision Maker, if other than the Architect.)

<< >>

<< >>

<< >>

<< >>

§ 6.2 Binding Dispute Resolution

For any Claim subject to, but not resolved by, mediation pursuant to Article 15 of AIA Document A201–2017, the method of binding dispute resolution shall be as follows:

(Check the appropriate box.)

Arbitration pursuant to Section 15.4 of AIA Document A201–2017

Litigation in a court of competent jurisdiction

Other *(Specify)*

If the Owner and Contractor do not select a method of binding dispute resolution, or do not subsequently agree in writing to a binding dispute resolution method other than litigation, Claims will be resolved by litigation in a court of competent jurisdiction.

ARTICLE 7 TERMINATION OR SUSPENSION

§ 7.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A201–2017.

§ 7.1.1 If the Contract is terminated for the Owner’s convenience in accordance with Article 14 of AIA Document A201–2017, then the Owner shall pay the Contractor a termination fee as follows:

(Insert the amount of, or method for determining, the fee, if any, payable to the Contractor following a termination for the Owner’s convenience.)

§ 7.2 The Work may be suspended by the Owner as provided in Article 14 of AIA Document A201–2017.

ARTICLE 8 MISCELLANEOUS PROVISIONS

§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A201–2017 or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 The Owner’s representative:

(Name, address, email address, and other information)

§ 8.3 The Contractor’s representative:

(Name, address, email address, and other information)

§ 8.4 Neither the Owner’s nor the Contractor’s representative shall be changed without ten days’ prior notice to the other party.

§ 8.5 Insurance and Bonds

§ 8.5.1 The Owner and the Contractor shall purchase and maintain insurance as set forth in AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum, Exhibit A, Insurance and Bonds, and elsewhere in the Contract Documents.

§ 8.5.2 The Contractor shall provide bonds as set forth in AIA Document A101™–2017 Exhibit A, and elsewhere in the Contract Documents.

§ 8.6 Notice in electronic format, pursuant to Article 1 of AIA Document A201–2017, may be given in accordance with AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, if completed, or as otherwise set forth below:

(If other than in accordance with AIA Document E203–2013, insert requirements for delivering notice in electronic format such as name, title, and email address of the recipient and whether and how the system will be required to generate a read receipt for the transmission.)

<< >>

§ 8.7 Other provisions:

<< >>

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS

§ 9.1 This Agreement is comprised of the following documents:

- .1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor
- .2 AIA Document A101™–2017, Exhibit A, Insurance and Bonds
- .3 AIA Document A201™–2017, General Conditions of the Contract for Construction
- .4 AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:

(Insert the date of the E203-2013 incorporated into this Agreement.)

<< >>

.5 Drawings

Number	Title	Date

.6 Specifications

Section	Title	Date	Pages

.7 Addenda, if any:

Number	Date	Pages

Portions of Addenda relating to bidding or proposal requirements are not part of the Contract Documents unless the bidding or proposal requirements are also enumerated in this Article 9.

.8 Other Exhibits:

(Check all boxes that apply and include appropriate information identifying the exhibit where required.)

[] AIA Document E204™–2017, Sustainable Projects Exhibit, dated as indicated below:
(Insert the date of the E204-2017 incorporated into this Agreement.)

<< >>

[« »] The Sustainability Plan:

Title	Date	Pages

[« »] Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages

.9 Other documents, if any, listed below:

(List here any additional documents that are intended to form part of the Contract Documents. AIA Document A201™-2017 provides that the advertisement or invitation to bid, Instructions to Bidders, sample forms, the Contractor's bid or proposal, portions of Addenda relating to bidding or proposal requirements, and other information furnished by the Owner in anticipation of receiving bids or proposals, are not part of the Contract Documents unless enumerated in this Agreement. Any such documents should be listed here only if intended to be part of the Contract Documents.)

« »

This Agreement entered into as of the day and year first written above.

OWNER (Signature)

« »« »

(Printed name and title)

CONTRACTOR (Signature)

« »« »

(Printed name and title)

Amendment to Contract for Construction
Between
Delaware Technical and Community College
And

The parties hereby agree and reaffirm that the AIA Document A101 – 2017 “Standard Form of Agreement between Owner and Contractor” between Delaware Technical and Community College (“Owner”) and _____, a _____ corporation (“Contractor”), dated _____, 201_, shall govern this transaction as supplemented by A201-2017 General Conditions for Construction and amended herein (“Contract Documents”). At times Owner and Contractor shall be collectively referred to the “Parties”.

The parties expressly agree to enter into this amendment (“Amendment”) which shall govern in the event of a conflict between the terms of the Contract Documents or any document referenced or incorporated therein, and that any contrary provision of any such document shall be superseded hereby. The parties agree to this Amendment as follows:

1. Contractor represents and warrants that it has not employed or retained any company or person, other than a bona fide employee working primarily for the firm offering professional services, to solicit or secure this agreement, and that he has not been paid or agreed to pay any person, company, corporation, individual, or firm, other than a bona fide employee working primarily for the firm offering professional services, any fee, commission, percentage, gift, or any other consideration, contingent upon or resulting from the award or making of this agreement;
2. All provisions of the Bid Package and Project manual are incorporated herein by reference as though fully set forth. In the event of a conflict between any provision of the Bid Package or Project Manual and the bid or proposal submitted by Contractor, the Bid Package and Project Manual shall control.
3. §3.3 is amended to require substantial completion of all construction not later than 455 days from the commencement of construction. Time is of the essence. If the Contractor fails to complete the work within the time specified, the Contractor shall pay liquidated damages to the Owner in the amount of \$0.00 for each calendar day of delay until the work is completed or accepted. If the Owner terminates the Contractor’s right to proceed, liquidated damages will continue to accrue until the work is completed. These liquidated damages are in addition to all sums and remedies available to Owner upon termination for cause.
4. In the event the attached contract or aggregate of contracts is in excess of \$500,000 for new construction (including painting and decorating) or \$45,000 for alteration, repair,

renovation, rehabilitation, demolition or reconstruction (including painting and decorating of buildings or works) and requires or involves the employment of mechanics and/or laborers, then the minimum wages to be paid to the various classes of laborers and mechanics shall be based upon greater of the Davis-Bacon Wage Rates (if the project is federally funded) or the wages that will be determined by the Delaware Department of Labor, Division of Industrial Affairs, to be prevailing in the county in which the work is to be performed.

5. Contractor shall pay all mechanics and laborers employed directly upon the site of the work, unconditionally and not less often than once a week and without subsequent deduction or rebate on any account, the full amounts accrued at time of payment, computed at wage rates not less than the prevailing wages, regardless of any contractual relationship which may be alleged to exist between the employer and such laborers and mechanics, and shall provide sworn payroll information, as required by the Department of Labor, on a weekly basis.
6. All changes to the scope of construction shall be authorized in writing by Owner in advance. Owner shall not be liable for payment of any change order that has not received prior written authorization. The cost of any change order shall be set forth therein. If no such provision is set forth in the change order, then the cost to the Owner shall be the Contractor's costs for wages, labor costs other than wages, wage taxes, materiel, equipment rentals, insurance and subcontracts attributable to the additional activity plus a reasonable sum for overhead and profit not to exceed 5%;
7. Preference in employment of laborers, workers or mechanics shall be given to bona fide legal citizens of the State who have established citizenship by residence of at least 90 days in the State. Contractor shall pay a penalty to the Secretary of Finance equal to the amount of compensation paid to any person in violation of this section;
8. Contractor shall not substitute another subcontractor for any subcontractor whose name was set forth in the statement which accompanied the bid without the written consent of Owner. Contractor shall pay a penalty equal to 150% of the amount of the proposal or subcontract submitted by the subcontractor identified in the accompanying statement for violating this paragraph.
9. Payments are due 30 days after receipt of a valid Application for Payment. Payments due and unpaid after 30 days shall bear simple interest at the rate of 1 percent per month not greater than 12% annual percentage rate;
10. Final payment shall not be due until all non-conforming work has been corrected and all other provisions of the agreement have been met, including, but not limited to, all reporting requirements. Furthermore, a written release of mechanics' liens signed by all persons who would otherwise be entitled to avail themselves of the provisions of Chapter 27 of Title 25 of the Delaware Code, containing a notarized, verified certification signed by the Contractor that all of the persons signing the release constitute all of the persons who have furnished materials and performed labor in and for the construction, erection,

building, improvement, alteration and repair to the date of the release and who would be entitled otherwise to file mechanics' liens claims shall be provided simultaneously with the receipt of final payment;

11. Owner may terminate this agreement or suspend work hereunder for any reason authorized by applicable Delaware law;
12. §6.2 is hereby deleted. The parties reserve all remedies available at law or equity for any dispute not resolved in accordance with §6.1;
13. §7.1.1 is hereby deleted and there shall be no Termination Fee paid to Contractor. Any reference to a Termination Fee in §14.4.3 of the A201-2017 is also deleted.
14. Any and all references to attorney's fees in §10.3.3 of the A201-2017 is deleted.
15. Exhibit A Insurance and Bonds is hereby deleted. Simultaneous with the execution of the this contract, Contractor shall also execute a good and sufficient bond for the benefit of Owner, with corporate surety authorized to do business in this State, in a sum equal to 100% of the contract price and the bond form used shall be the standard form issued by the Office of Management and Budget. The bond shall be conditioned upon the faithful compliance and performance by the successful bidder of each and every term and condition of the contract and the proposal and plans and specifications thereof, at the time and in the manner prescribed by the contract and the plans and specifications, including the payment in full, to every firm furnishing materiel or performing labor in the performance of the contract, of all sums of money due it for such labor or materiel. The bond shall also contain the Contractor's guarantee to indemnify and save harmless the Owner from all costs, damages and expenses growing out of or by reason of Contractor's failure to comply and perform the work and complete the contract in accordance with its terms. No firm or surety, in any action brought under 29 Del C §6962, or any successor law, or on the bond required by such statute, shall assert as a defense to such action the claim that the bond given contained a limitation or restriction not provided for by Chapter 69, Title 29 of the Delaware Code, the provisions of which are incorporated herein by reference as though fully set forth. Contractor shall obtain all insurance required by Owner and provide proof thereof prior to execution.;
16. Owner shall have the right to terminate the contract upon receipt of notice from Contractor's surety that bond claims have been made or are anticipated to be made against Contractor on this or any other project of Contractor. If Owner elects to terminate the contract pursuant to this paragraph, it shall be deemed a termination for cause.
17. Owner may, when it considers that its interests so require, cause judgment to be confessed upon the bond. All sums received through confession of judgment shall be paid for the credit of the Owner to the Secretary of Finance;
18. Owner or any of its duly authorized representatives shall have access to any documents, books, papers, and records of Contractor (which are directly pertinent to a specific grant

program) for the purpose of making an audit, examination, excerpts, and transcriptions. Contractor shall maintain all required records for at least three years after Owner makes final payment and all pending matters are closed;

- 19. Contractor shall submit a report to Owner not less frequently than monthly covering the general progress of the job and describing any problems or factors contributing to delay;
- 20. During the performance of this contract, the contractor agrees as follows:

The contractor will not discriminate against any employee or applicant for employment because of race, creed, color, sex, sexual orientation gender identity, pregnancy, or national origin. The contractor will take positive steps to ensure that applicants are employed and that employees are treated during employment without regard to their race, creed, color, sex, sexual orientation, gender identity, pregnancy, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places available to employees and applicants for employment notices to be provided by the contracting agency setting forth this nondiscrimination clause.

The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, sexual orientation or national origin.

- 21. The parties agree that this agreement shall be governed by and construed pursuant to the laws of The State of Delaware, and that the Delaware courts shall have sole and exclusive jurisdiction of any dispute arising under this agreement.

IN WITNESS WHEREOF, the parties, through their acknowledged and duly authorized agents set forth below, have set their hand and seal on this indenture on this _____ day of _____, 201__.

Delaware Technical and Community College

_____(Seal)
Mark T. Brainard, President

(Contractor)

_____(Seal)

By:

GENERAL REQUIREMENTS

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ARTICLE 1: GENERAL

1.1 CONTRACT DOCUMENTS

1.1.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary and what is required by one shall be as binding as if required by all. Performance by the Contractor shall be required to an extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results.

1.1.2 Work including material purchases shall not begin until the Contractor is in receipt of a bonafide State of Delaware Purchase Order. Any work performed or material purchases prior to the issuance of the Purchase Order is done at the Contractor's own risk and cost.

1.2 EQUALITY OF EMPLOYMENT OPPORTUNITY ON PUBLIC WORKS

1.2.1 For Public Works Projects financed in whole or in part by state appropriation the Contractor agrees that during the performance of this contract:

1. The Contractor will not discriminate against any employee or applicant for employment because of race, creed, sex, color, sexual orientation, gender identity or national origin. The Contractor will take positive steps to ensure that applicants are employed and that employees are treated during employment without regard to their race, creed, sex, color, sexual orientation, gender identity or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places available to employees and applicants for employment notices to be provided by the contracting agency setting forth this nondiscrimination clause.
2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, sex, color, sexual orientation, gender identity or national origin."

ARTICLE 2: OWNER

(NO ADDITIONAL GENERAL REQUIREMENTS – SEE SUPPLEMENTARY GENERAL CONDITIONS)

ARTICLE 3: CONTRACTOR

3.1 Schedule of Values: The successful Bidder shall within twenty (20) days after receiving notice to proceed with the work, furnish to the Owner a complete schedule of values on the various items comprising the work.

3.2 Subcontracts: Upon approval of Subcontractors, the Contractor shall award their Subcontracts as soon as possible after the signing of their own contract and see that all material, their own and those of their Subcontractors, are promptly ordered so that the work will not be delayed by failure of materials to arrive on time.

3.3 Before commencing any work or construction, the General Contractor is to consult with the Owner as to matters in connection with access to the site and the allocation of Ground Areas for the various features of hauling, storage, etc.

- 3.4 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions.
- 3.5 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Contract. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them.
- 3.6 The Contractor warrants to the Owner that materials and equipment furnished will be new and of good quality, unless otherwise permitted, and that the work will be free from defects and in conformance with the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved, may be considered defective. If required by the Owner, the Contractor shall furnish evidence as to the kind and quality of materials and equipment provided.
- 3.7 Unless otherwise provided, the Contractor shall pay all sales, consumer, use and other similar taxes, and shall secure and pay for required permits, fees, licenses, and inspections necessary for proper execution of the Work.
- 3.8 The Contractor shall comply with and give notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities bearing on performance of the Work. The Contractor shall promptly notify the Owner if the Drawings and Specifications are observed to be at variance therewith.
- 3.9 The Contractor shall be responsible to the Owner for the acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons performing portions of the Work under contract with the Contractor.
- 3.10 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work the Contractor shall remove from and about the Project all waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials. The Contractor shall be responsible for returning all damaged areas to their original conditions.
- 3.11 STATE LICENSE AND TAX REQUIREMENTS
- 3.11.1 Each Contractor and Subcontractor shall be licensed to do business in the State of Delaware and shall pay all fees and taxes due under State laws. In conformance with Section 2503, Chapter 25, Title 30, Delaware Code, "the Contractor shall furnish the Delaware Department of Finance within ten (10) days after entering into any contract with a contractor or subcontractor not a resident of this State, a statement of total value of such contract or contracts together with the names and addresses of the contracting parties."
- 3.12 The Contractor shall comply with all requirements set forth in Section 6962, Chapter 69, Title 29 of the Delaware Code.

- 3.13 During the contract Work, the Contractor and each Subcontractor, shall implement an Employee Drug Testing Program in accordance with OMB Regulation 4104 - "Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on "Large Public Works Projects". "Large Public Works" is based upon the current threshold required for bidding Public Works as set by the Purchasing and Contracting Advisory Council.

ARTICLE 4: ADMINISTRATION OF THE CONTRACT

4.1 CONTRACT SURETY

4.1.1 PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND

- 4.1.2 All bonds will be required as follows unless specifically waived elsewhere in the Bidding Documents.

- 4.1.3 Contents of Performance Bonds – The bond shall be in the form approved by the Office of Management and Budget. The bond shall be conditioned upon the faithful compliance and performance by the successful bidder of each and every term and condition of the contract and the proposal, plans, specifications, and bid documents thereof. Each term and condition shall be met at the time and in the manner prescribed by the Contract, Bid documents and the specifications, including the payment in full to every person furnishing material or performing labor in the performance of the Contract, of all sums of money due the person for such labor and material. (The bond shall also contain the successful bidder's guarantee to indemnify and save harmless the State and the agency from all costs, damages and expenses growing out of or by reason of the Contract in accordance with the Contract.)

- 4.1.4 Invoking a Performance Bond – The agency may, when it considers that the interest of the State so requires, cause judgement to be confessed upon the bond.

- 4.1.5 Within twenty (20) days after the date of notice of award of contract, the Bidder to whom the award is made shall furnish a Performance Bond and Labor and Material Payment Bond, each equal to the full amount of the Contract price to guarantee the faithful performance of all terms, covenants and conditions of the same. The bonds are to be issued by an acceptable Bonding Company licensed to do business in the State of Delaware and shall be issued in duplicate.

- 4.1.6 Performance and Payment Bonds shall be maintained in full force (warranty bond) for a period of two (2) years after the date of the Certificate for Final Payment. The Performance Bond shall guarantee the satisfactory completion of the Project and that the Contractor will make good any faults or defects in his work which may develop during the period of said guarantees as a result of improper or defective workmanship, material or apparatus, whether furnished by themselves or their Sub-Contractors. The Payment Bond shall guarantee that the Contractor shall pay in full all persons, firms or corporations who furnish labor or material or both labor and material for, or on account of, the work included herein. The bonds shall be paid for by this Contractor. The Owner shall have the right to demand that the proof parties signing the bonds are duly authorized to do so.

4.2 FAILURE TO COMPLY WITH CONTRACT

4.2.1 If any firm entering into a contract with the State, or Agency that neglects or refuses to perform or fails to comply with the terms thereof, the Agency which signed the Contract may terminate the Contract and proceed to award a new contract in accordance with this Chapter 69, Title 29 of the Delaware Code or may require the Surety on the Performance Bond to complete the Contract in accordance with the terms of the Performance Bond. Nothing herein shall preclude the Agency from pursuing additional remedies as otherwise provided by law.

4.3 CONTRACT INSURANCE AND CONTRACT LIABILITY

4.3.1 In addition to the bond requirements stated in the Bid Documents, each successful Bidder shall purchase adequate insurance for the performance of the Contract and, by submission of a Bid, agrees to indemnify and save harmless and to defend all legal or equitable actions brought against the State, any Agency, officer and/or employee of the State, for and from all claims of liability which is or may be the result of the successful Bidder's actions during the performance of the Contract.

4.3.2 The purchase or nonpurchase of such insurance or the involvement of the successful Bidder in any legal or equitable defense of any action brought against the successful Bidder based upon work performed pursuant to the Contract will not waive any defense which the State, its agencies and their respective officers, employees and agents might otherwise have against such claims, specifically including the defense of sovereign immunity, where applicable, and by the terms of this section, the State and all agencies, officers and employees thereof shall not be financially responsible for the consequences of work performed, pursuant to said contract.

4.4 RIGHT TO AUDIT RECORDS

4.4.1 The Owner shall have the right to audit the books and records of a Contractor or any Subcontractor under any Contract or Subcontract to the extent that the books and records relate to the performance of the Contract or Subcontract.

4.4.2 Said books and records shall be maintained by the Contractor for a period of seven (7) years from the date of final payment under the Prime Contract and by the Subcontractor for a period of seven (7) years from the date of final payment under the Subcontract.

ARTICLE 5: SUBCONTRACTORS

5.1 SUBCONTRACTING REQUIREMENTS

5.1.1 All contracts for the construction, reconstruction, alteration or repair of any public building (not a road, street or highway) shall be subject to the following provisions:

1. A contract shall be awarded only to a Bidder whose Bid is accompanied by a statement containing, for each Subcontractor category, the name and address (city or town and State only – street number and P.O. Box addresses not required) of the subcontractor whose services the Bidder intends to use in performing the Work and providing the material for such Subcontractor category.

2. A Bid will not be accepted nor will an award of any Contract be made to any Bidder which, as the Prime Contractor, has listed itself as the Subcontractor for any Subcontractor unless:
 - A. It has been established to the satisfaction of the awarding Agency that the Bidder has customarily performed the specialty work of such Subcontractor category by artisans regularly employed by the Bidder's firm;
 - B. That the Bidder is duly licensed by the State to engage in such specialty work, if the State requires licenses; and
 - C. That the Bidder is recognized in the industry as a bona fide Subcontractor or Contractor in such specialty work and Subcontractor category.
- 5.1.2 The decision of the awarding Agency as to whether a Bidder who list itself as the Subcontractor for a Subcontractor category shall be final and binding upon all Bidders, and no action of any nature shall lie against any awarding agency or its employees or officers because of its decision in this regard.
- 5.1.3 After such a Contract has been awarded, the successful Bidder shall not substitute another Subcontractor for any Subcontractor whose name was set forth in the statement which accompanied the Bid without the written consent of the awarding Agency.
- 5.1.4 No Agency shall consent to any substitution of Subcontractors unless the Agency is satisfied that the Subcontractor whose name is on the Bidders accompanying statement:
 - A. Is unqualified to perform the work required;
 - B. Has failed to execute a timely reasonable Subcontract;
 - C. Has defaulted in the performance on the portion of the work covered by the Subcontract; or
 - D. Is no longer engaged in such business.
- 5.1.5 Should a Bidder be awarded a contract, such successful Bidder shall provide to the agency the taxpayer identification license numbers of such subcontractors. Such numbers shall be provided on the later of the date on which such subcontractor is required to be identified or the time the contract is executed. The successful Bidder shall provide to the agency to which it is contracting, within 30 days of entering into such public works contract, copies of all Delaware Business licenses of subcontractors and/or independent contractors that will perform work for such public works contract. However, if a subcontractor or independent contractor is hired or contracted more than 20 days after the Bidder entered the public works contract the Delaware Business license of such subcontractor or independent contractor shall be provided to the agency within 10 days of being contracted or hired.
- 5.1.6 The Contractor may employ additional Subcontractors on the jobsite only after submitting a copy of the Subcontractor's Employee Drug Testing Program to the Owner for approval. A Contractor or Subcontractor shall not commence work until the Owner has concluded its review and determined that the submitted Employee Drug Testing Program complies with OMB Regulation 4104.

5.2 PENALTY FOR SUBSTITUTION OF SUBCONTRACTORS

5.2.1 Should the Contractor fail to utilize any or all of the Subcontractors in the Contractor's Bid statement in the performance of the Work on the public bidding, the Contractor shall be penalized in the amount of (project specific amount*). The Agency may determine to deduct payments of the penalty from the Contractor or have the amount paid directly to the Agency. Any penalty amount assessed against the Contractor may be remitted or refunded, in whole or in part, by the Agency awarding the Contract, only if it is established to the satisfaction of the Agency that the Subcontractor in question has defaulted or is no longer engaged in such business. No claim for the remission or refund of any penalty shall be granted unless an application is filed within one year after the liability of the successful Bidder accrues. All penalty amounts assessed and not refunded or remitted to the contractor shall be reverted to the State.

*one (1) percent of contract amount not to exceed \$10,000

5.3 ASBESTOS ABATEMENT

5.3.1 The selection of any Contractor to perform asbestos abatement for State-funded projects shall be approved by the Office of Management and Budget, Division of Facilities Management pursuant to Chapter 78 of Title 16.

5.4 STANDARDS OF CONSTRUCTION FOR THE PROTECTION OF THE PHYSICALLY HANDICAPPED

5.4.1 All Contracts shall conform with the standard established by the Delaware Architectural Accessibility Board unless otherwise exempted by the Board.

5.5 CONTRACT PERFORMANCE

5.5.1 Any firm entering into a Public Works Contract that neglects or refuses to perform or fails to comply with its terms, the Agency may terminate the Contract and proceed to award a new Contract or may require the Surety on the Performance Bond to complete the Contract in accordance with the terms of the Performance Bond.

ARTICLE 6: CONSTRUCTION BY OWNER OR SEPARATE CONTRACTORS

6.1 The Owner reserves the right to simultaneously perform other construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other Projects at the same site.

6.2 The Contractor shall afford the Owner and other Contractors reasonable opportunity for access and storage of materials and equipment, and for the performance of their activities, and shall connect and coordinate their activities with other forces as required by the Contract Documents.

ARTICLE 7: CHANGES IN THE WORK

7.1 The Owner, without invalidating the Contract, may order changes in the Work consisting of Additions, Deletions, Modifications or Substitutions, with the Contract Sum and Contract completion date being adjusted accordingly. Such changes in the Work shall be authorized by written Change Order signed by the Professional, as the duly authorized agent, the Contractor and the Owner.

- 7.2 The Contract Sum and Contract Completion Date shall be adjusted only by a fully executed Change Order.
- 7.3 The additional cost, or credit to the Owner resulting from a change in the Work shall be by mutual agreement of the Owner, Contractor and the Architect. In all cases, this cost or credit shall be based on the 'DPE' wages required and the "invoice price" of the materials/equipment needed.
- 7.3.1 "DPE" shall be defined to mean "direct personnel expense". Direct payroll expense includes prevailing wage rates plus a maximum multiplier of 1.35 times DPE. For example, if the prevailing wage rate is \$50/hour, the DPE would be \$67.50/hour (50 x 1.35).
- 7.3.2 "Invoice price" of materials/equipment shall be defined to mean the actual cost of materials and/or equipment that is paid by the Contractor, (or subcontractor), to a material distributor, direct factory vendor, store, material provider, or equipment leasing entity. Rates for equipment that is leased and/or owned by the Contractor or subcontractor(s) shall not exceed those listed in the latest version of the "Means Building Construction Cost Data" publication.
- 7.3.3 In addition to the above, the General Contractor is allowed a fifteen percent (15%) markup for overhead and profit for additional work performed by the General Contractor's own forces. For additional subcontractor work, the Subcontractor is allowed a fifteen (15) percent overhead and profit on change order work above and beyond the direct costs stated previously. To this amount, the General Contractor will be allowed a mark-up not exceeding seven and one half percent (7.5%) on the subcontractors work. These mark-ups shall include all costs including, but not limited to: overhead, profit, bonds, insurance, supervision, etc. No markup is permitted on the work of the subcontractors subcontractor. No additional costs shall be allowed for changes related to the Contractor's onsite superintendent/staff, or project manager, unless a change in the work changes the project duration and is identified by the CPM schedule. There will be no other costs associated with the change order.

ARTICLE 8: TIME

- 8.1 Time limits, if any, are as stated in the Project Manual. By executing the Agreement, the Contractor confirms that the stipulated limits are reasonable, and that the Work will be completed within the anticipated time frame.
- 8.2 If progress of the Work is delayed at any time by changes ordered by the Owner, by labor disputes, fire, unusual delay in deliveries, abnormal adverse weather conditions, unavoidable casualties or other causes beyond the Contractor's control, the Contract Time shall be extended for such reasonable time as the Owner may determine.
- 8.3 Any extension of time beyond the date fixed for completion of the construction and acceptance of any part of the Work called for by the Contract, or the occupancy of the building by the Owner, in whole or in part, previous to the completion shall not be deemed a waiver by the Owner of his right to annul or terminate the Contract for abandonment or delay in the matter provided for, nor relieve the Contractor of full responsibility.

8.4 SUSPENSION AND DEBARMENT

8.4.1 Per Section 6962(d)(14), Title 29, Delaware Code, "Any Contractor who fails to perform a public works contract or complete a public works project within the time schedule established by the Agency in the Invitation To Bid, may be subject to Suspension or Debarment for one or more of the following reasons: a) failure to supply the adequate labor supply ratio for the project; b) inadequate financial resources; or, c) poor performance on the Project."

8.4.2 "Upon such failure for any of the above stated reasons, the Agency that contracted for the public works project may petition the Director of the Office of Management and Budget for Suspension or Debarment of the Contractor. The Agency shall send a copy of the petition to the Contractor within three (3) working days of filing with the Director. If the Director concludes that the petition has merit, the Director shall schedule and hold a hearing to determine whether to suspend the Contractor, debar the Contractor or deny the petition. The Agency shall have the burden of proving, by a preponderance of the evidence, that the Contractor failed to perform or complete the public works project within the time schedule established by the Agency and failed to do so for one or more of the following reasons: a) failure to supply the adequate labor supply ratio for the project; b) inadequate financial resources; or, c) poor performance on the project. Upon a finding in favor of the Agency, the Director may suspend a Contractor from Bidding on any project funded, in whole or in part, with public funds for up to 1 year for a first offense, up to 3 years for a second offense and permanently debar the Contractor for a third offense. The Director shall issue a written decision and shall send a copy to the Contractor and the Agency. Such decision may be appealed to the Superior Court within thirty (30) days for a review on the record."

8.5 RETAINAGE

8.5.1 Per Section 6962(d)(5) a.3, Title 29, Delaware Code: The Agency may at the beginning of each public works project establish a time schedule for the completion of the project. If the project is delayed beyond the completion date due to the Contractor's failure to meet their responsibilities, the Agency may forfeit, at its discretion, all or part of the Contractor's retainage.

8.5.2 This forfeiture of retainage also applies to the timely completion of the punchlist. A punchlist will only be prepared upon the mutual agreement of the Owner, Architect and Contractor. Once the punchlist is prepared, all three parties will by mutual agreement, establish a schedule for its completion. Should completion of the punchlist be delayed beyond the established date due to the Contractor's failure to meet their responsibilities, the Agency may hold permanently, at its discretion, all or part of the Contractor's retainage.

ARTICLE 9: PAYMENTS AND COMPLETION

9.1 APPLICATION FOR PAYMENT

9.1.1 Applications for payment shall be made upon AIA Document G702. There will be a five percent (5%) retainage on all Contractor's monthly invoices until completion of the project. This retainage may become payable upon receipt of all required closeout documentation, provided all other requirements of the Contract Documents have been met.

9.1.2 A date will be fixed for the taking of the monthly account of work done. Upon receipt of Contractor's itemized application for payment, such application will be audited, modified, if found necessary, and approved for the amount. Statement shall be submitted to the Owner.

9.1.3 Section 6516, Title 29 of the Delaware Code annualized interest is not to exceed 12% per annum beginning thirty (30) days after the “presentment” (as opposed to the date) of the invoice.

9.2 PARTIAL PAYMENTS

9.2.1 Any public works Contract executed by any Agency may provide for partial payments at the option of the Owner with respect to materials placed along or upon the sites or stored at secured locations, which are suitable for use in the performance of the contract.

9.2.2 When approved by the agency, partial payment may include the values of tested and acceptable materials of a nonperishable or noncontaminative nature which have been produced or furnished for incorporation as a permanent part of the work yet to be completed, provided acceptable provisions have been made for storage.

9.2.2.1 Any allowance made for materials on hand will not exceed the delivered cost of the materials as verified by invoices furnished by the Contractor, nor will it exceed the contract bid price for the material complete in place.

9.2.3 If requested by the Agency, receipted bills from all Contractors, Subcontractors, and material, men, etc., for the previous payment must accompany each application for payment. Following such a request, no payment will be made until these receipted bills have been received by the Owner.

9.3 SUBSTANTIAL COMPLETION

9.3.1 When the building has been made suitable for occupancy, but still requires small items of miscellaneous work, the Owner will determine the date when the project has been substantially completed.

9.3.2 If, after the Work has been substantially completed, full completion thereof is materially delayed through no fault of the Contractor, and without terminating the Contract, the Owner may make payment of the balance due for the portion of the Work fully completed and accepted. Such payment shall be made under the terms and conditions governing final payment that it shall not constitute a waiver of claims.

9.3.3 On projects where commissioning is included, the commissioning work as defined in the specifications must be complete prior to the issuance of substantial completion.

9.4 FINAL PAYMENT

9.4.1 Final payment, including the five percent (5%) retainage if determined appropriate, shall be made within thirty (30) days after the Work is fully completed and the Contract fully performed and provided that the Contractor has submitted the following closeout documentation (in addition to any other documentation required elsewhere in the Contract Documents):

9.4.1.1 Evidence satisfactory to the Owner that all payrolls, material bills, and other indebtedness connected with the work have been paid,

9.4.1.2 An acceptable RELEASE OF LIENS,

9.4.1.3 Copies of all applicable warranties,

9.4.1.4 As-built drawings,

- 9.4.1.5 Operations and Maintenance Manuals,
- 9.4.1.6 Instruction Manuals,
- 9.4.1.7 Consent of Surety to final payment.
- 9.4.1.8 The Owner reserves the right to retain payments, or parts thereof, for its protection until the foregoing conditions have been complied with, defective work corrected and all unsatisfactory conditions remedied.

ARTICLE 10: PROTECTION OF PERSONS AND PROPERTY

- 10.1 The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract. The Contractor shall take all reasonable precautions to prevent damage, injury or loss to: workers, persons nearby who may be affected, the Work, materials and equipment to be incorporated, and existing property at the site or adjacent thereto. The Contractor shall give notices and comply with applicable laws ordinances, rules regulations, and lawful orders of public authorities bearing on the safety of persons and property and their protection from injury, damage, or loss. The Contractor shall promptly remedy damage and loss to property at the site caused in whole or in part by the Contractor, a Subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable.
- 10.2 The Contractor shall notify the Owner in the event any existing hazardous material such as lead, PCBs, asbestos, etc. is encountered on the project. The Owner will arrange with a qualified specialist for the identification, testing, removal, handling and protection against exposure or environmental pollution, to comply with applicable regulation laws and ordinances. The Contractor and Architect will not be required to participate in or to perform this operation. Upon completion of this work, the Owner will notify the Contractor and Architect in writing the area has been cleared and approved by the authorities in order for the work to proceed. The Contractor shall attach documentation from the authorities of said approval.
- 10.3 As required in the Hazardous Chemical Information Act of June 1984, all vendors supplying any materials that may be defined as hazardous, must provide Material Safety Data Sheets for those products. Any chemical product should be considered hazardous if it has a warning caution on the label relating to a potential physical or health hazard, if it is known to be present in the work place, and if employees may be exposed under normal conditions or in any foreseeable emergency situation. Material Safety Data Sheets must be provided directly to the Owner along with the shipping slips that include those products.
- 10.4 The Contractor shall certify to the Owner that materials incorporated into the Work are free of all asbestos. This certification may be in the form of Material Safety Data Sheet (MSDS) provided by the product manufacturer for the materials used in construction, as specified or as provided by the Contractor.

ARTICLE 11: INSURANCE AND BONDS

- 11.1 The Contractor shall carry all insurance required by law, such as Unemployment Insurance, etc. The Contractor shall carry such insurance coverage as they desire on their own property such as a field office, storage sheds or other structures erected upon the project site that belong to them and for their own use. The Subcontractors involved with this project shall carry whatever insurance protection they consider necessary to cover the loss of any of their personal property, etc.

11.2 Upon being awarded the Contract, the Contractor shall obtain a minimum of two (2) copies of all required insurance certificates called for herein, and submit one (1) copy of each certificate, to the Owner, within 20 days of contract award.

11.3 Bodily Injury Liability and Property Damage Liability Insurance shall, in addition to the coverage included herein, include coverage for injury to or destruction of any property arising out of the collapse of or structural injury to any building or structure due to demolition work and evidence of these coverages shall be filed with and approved by the Owner.

11.4 The Contractor's Property Damage Liability Insurance shall, in addition to the coverage noted herein, include coverage on all real and personal property in their care, custody and control damaged in any way by the Contractor or their Subcontractors during the entire construction period on this project.

11.5 Builders Risk (including Standard Extended Coverage Insurance) on the existing building during the entire construction period, may be provided by the Contractor under this contract. The Owner shall insure the existing building and all of its contents and all this new alteration work under this contract during entire construction period for the full insurable value of the entire work at the site. Note, however, that the Contractor and their Subcontractors shall be responsible for insuring building materials (installed and stored) and their tools and equipment whenever in use on the project, against fire damage, theft, vandalism, etc.

11.6 Certificates of the insurance company or companies stating the amount and type of coverage, terms of policies, etc., shall be furnished to the Owner, within 20 days of contract award.

11.7 The Contractor shall, at their own expense, (in addition to the above) carry the following forms of insurance:

11.7.1 Contractor's Contractual Liability Insurance

Minimum coverage to be:

Bodily Injury	\$500,000 \$1,000,000 \$3,000,000	for each person for each occurrence aggregate
Property Damage	\$500,000 \$1,000,000	for each occurrence aggregate

11.7.2 Contractor's Protective Liability Insurance

Minimum coverage to be:

Bodily Injury	\$500,000 \$1,000,000 \$3,000,000	for each person for each occurrence aggregate
Property Damage	\$500,000 \$1,000,000	for each occurrence aggregate

11.7.3 Automobile Liability Insurance

Minimum coverage to be:

Bodily Injury	\$1,000,000	for each person
	\$3,000,000	for each occurrence
Property Damage	\$500,000	per accident

11.7.4 Prime Contractor's and Subcontractors' policies shall include contingent and contractual liability coverage in the same minimum amounts as 11.7.1 above.

11.7.5 Workmen's Compensation (including Employer's Liability):

11.7.5.1 Minimum Limit on employer's liability to be as required by law.

11.7.5.2 Minimum Limit for all employees working at one site.

11.7.6 Certificates of Insurance must be filed with the Owner guaranteeing fifteen (15) days prior notice of cancellation, non-renewal, or any change in coverages and limits of liability shown as included on certificates.

11.7.7 Social Security Liability

11.7.7.1 With respect to all persons at any time employed by or on the payroll of the Contractor or performing any work for or on their behalf, or in connection with or arising out of the Contractor's business, the Contractor shall accept full and exclusive liability for the payment of any and all contributions or taxes or unemployment insurance, or old age retirement benefits, pensions or annuities now or hereafter imposed by the Government of the United States and the State or political subdivision thereof, whether the same be measured by wages, salaries or other remuneration paid to such persons or otherwise.

11.7.7.2 Upon request, the Contractor shall furnish Owner such information on payrolls or employment records as may be necessary to enable it to fully comply with the law imposing the aforesaid contributions or taxes.

11.7.7.3 If the Owner is required by law to and does pay any and/or all of the aforesaid contributions or taxes, the Contractor shall forthwith reimburse the Owner for the entire amount so paid by the Owner.

ARTICLE 12: UNCOVERING AND CORRECTION OF WORK

12.1 The Contractor shall promptly correct Work rejected by the Owner or failing to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed, and shall correct any Work found to be not in accordance with the requirements of the Contract Documents within a period of two years from the date of Substantial Completion, or by terms of an applicable special warranty required by the Contract Documents. The provisions of this Article apply to work done by Subcontractors as well as to Work done by direct employees of the Contractor.

12.2 At any time during the progress of the work, or in any case where the nature of the defects shall be such that it is not expedient to have them corrected, the Owner, at their option, shall have the right to deduct such sum, or sums, of money from the amount of the contract as they consider justified to adjust the difference in value between the defective work and that required under contract including any damage to the structure.

ARTICLE 13: MISCELLANEOUS PROVISIONS

13.1 CUTTING AND PATCHING

13.1.1 The Contractor shall be responsible for all cutting and patching. The Contractor shall coordinate the work of the various trades involved.

13.2 DIMENSIONS

13.2.1 All dimensions shown shall be verified by the Contractor by actual measurements at the project site. Any discrepancies between the drawings and specifications and the existing conditions shall be referred to the Owner for adjustment before any work affected thereby has been performed.

13.3 LABORATORY TESTS

13.3.1 Any specified laboratory tests of material and finished articles to be incorporated in the work shall be made by bureaus, laboratories or agencies approved by the Owner and reports of such tests shall be submitted to the Owner. The cost of the testing shall be paid for by the Contractor.

13.3.2 The Contractor shall furnish all sample materials required for these tests and shall deliver same without charge to the testing laboratory or other designated agency when and where directed by the Owner.

13.4 ARCHAEOLOGICAL EVIDENCE

13.4.1 Whenever, in the course of construction, any archaeological evidence is encountered on the surface or below the surface of the ground, the Contractor shall notify the authorities of the State Historic Preservation Office and suspend work in the immediate area for a reasonable time to permit those authorities, or persons designated by them, to examine the area and ensure the proper removal of the archaeological evidence for suitable preservation by the Division of Historical and Cultural Affairs.

13.5 GLASS REPLACEMENT AND CLEANING

13.5.1 The General Contractor shall replace without expense to the Owner all glass broken during the construction of the project. If job conditions warrant, at completion of the job the General Contractor shall have all glass cleaned and polished.

13.6 WARRANTY

13.6.1 For a period of two (2) years from the date of substantial completion, as evidenced by the date of final acceptance of the work, the contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect of equipment, material or workmanship performed by the contractor or any of his subcontractors or suppliers. However, manufacturer's warranties and guarantees, if for a period longer than two (2) years, shall take precedence over the above warranties. The contractor shall remedy, at his own expense, any such failure to conform or any such defect. The protection of this warranty shall be included in the Contractor's Performance Bond.

ARTICLE 14: TERMINATION OF CONTRACT

- 14.1 If the Contractor defaults or persistently fails or neglects to carry out the Work in accordance with the Contract Documents or fails to perform a provision of the Contract, the Owner, after seven days written notice to the Contractor, may make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Contractor. Alternatively, at the Owner's option, and the Owner may terminate the Contract and take possession of the site and of all materials, equipment, tools, and machinery thereon owned by the Contractor and may finish the Work by whatever method the Owner may deem expedient. If the costs of finishing the Work exceed any unpaid compensation due the Contractor, the Contractor shall pay the difference to the Owner.
- 14.2 "If the continuation of this Agreement is contingent upon the appropriation of adequate state, or federal funds, this Agreement may be terminated on the date beginning on the first fiscal year for which funds are not appropriated or at the exhaustion of the appropriation. The Owner may terminate this Agreement by providing written notice to the parties of such non-appropriation. All payment obligations of the Owner will cease upon the date of termination. Notwithstanding the foregoing, the Owner agrees that it will use its best efforts to obtain approval of necessary funds to continue the Agreement by taking appropriate action to request adequate funds to continue the Agreement."

END OF GENERAL REQUIREMENTS

SUPPLEMENTARY GENERAL CONDITIONS A201-2017

The following supplements modify the "General Conditions of the Contract for Construction," AIA Document A201-2017. Where a portion of the General Conditions is modified or deleted by the Supplementary Conditions, the unaltered portions of the General Conditions shall remain in effect.

TABLE OF ARTICLES

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2. OWNER
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ARTICLE 1: GENERAL PROVISIONS

1.1 BASIC DEFINITIONS

1.1.1 THE CONTRACT DOCUMENTS

Strike the last sentence of Section 1.1.1 in its entirety and replace with the following:

“The Contract Documents also include Advertisement for Bid, Instructions to Bidder, sample forms, the Bid Form, the Contractor’s completed Bid and the Award Letter.”

Add the following Section:

“1.1.1.1 In the event of conflict or discrepancies among the Contract Documents, the Documents prepared by the Delaware Technical and Community College shall take precedence over all other documents.”

1.1.8 INITIAL DECISION MAKER

Strike the last sentence of Section 1.1.8 in its entirety and add the following to the end of the remaining sentence:

“ and certify termination of the Agreement under Section 14.2.2.”

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

1.2.1.1 Insert “if possible” at the end of the second sentence.

Add the following Sections:

“1.2.4 In the case of an inconsistency between the Drawings and the Specifications, or within either document not clarified by addendum, the better quality or greater quantity of work shall be provided in accordance with the Architect’s interpretation.”

“1.2.5 The word “PROVIDE” as used in the Contract Documents shall mean “FURNISH AND INSTALL” and shall include, without limitation, all labor, materials, equipment, transportation, services and other items required to complete the Work.”

“1.2.6 The word “PRODUCT” as used in the Contract Documents means all materials, systems and equipment.”

1.5 OWNERSHIP AND USE OF DRAWINGS, SPECIFICATIONS AND OTHER INSTRUMENTS OF SERVICE

Strike Section 1.5.1 in its entirety and replace with the following:

“All pre-design studies, drawings, specifications and other documents, including those in electronic form, prepared by the Architect under this Agreement are, and shall remain, the property of the Owner whether the Project for which they are made is executed or not. Such documents may be used by the Owner to construct one or more like Projects without the approval of, or additional compensation to, the Architect. The Contractor, Subcontractors, Sub-subcontractors, and Material or Equipment Suppliers are authorized to use and reproduce applicable portions of the Drawings, Specifications and other documents prepared by the Architect and the Architect’s consultants appropriate to and

for use in the execution of their Work under the Contract Documents. They are not to be used by the Contractor or any Subcontractor, Sub-subcontractor or Material and Equipment Supplier on other Projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect and Architect's consultants.

The Architect shall not be liable for injury or damage resulting from the re-use of drawings and specifications if the Architect is not involved in the re-use Project. Prior to re-use of construction documents for a Project in which the Architect is not also involved, the Owner will remove from such documents all identification of the original Architect, including name, address and professional seal or stamp."

Strike Section 1.5.2 in its entirety.

1.7 DIGITAL DATA USE AND TRANSMISSION

Strike Section 1.7 in its entirety and replace with the following:

"The parties shall agree upon protocols governing transmission and use of Instruments of Service or any other information or documentation in digital form."

1.8 BUILDING INFORMATION MODELS USE AND RELIANCE

Strike Section 1.8 in its entirety.

ARTICLE 2: OWNER

2.2 EVIDENCE OF THE OWNERS FINANCIAL ARRANGEMENTS

Strike Section 2.2 in its entirety.

2.3 INFORMATION AND SERVICES REQUIRED OF THE OWNER

2.3.3 Strike 2.3.3 in its entirety.

2.3.4 Add the following sentence at the end of the paragraph:

"The Contractor, at their expense shall bear the costs to accurately identify the location of all underground utilities in the area of their excavation and shall bear all cost for any repairs required, out of failure to accurately identify said utilities."

Strike Section 2.3.6 in its entirety and replace with the following:

"2.3.6 The Contractor shall be furnished free of charge (1) electronic set of the Drawings and Project Manuals. Additional sets will be furnished at the cost of reproduction, postage and handling."

2.5 OWNER'S RIGHT TO CARRY OUT THE WORK

Add ", except as outlined in Section 3.15" after the reference to "Article 15" at the end of the last sentence of the Section.

ARTICLE 3: CONTRACTOR

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

3.2.2 Add "and Owner" after "report to the Architect" in the second sentence.

3.2.4 Strike "subject to Section 15.1.7" in the second sentence.

3.2.4 Strike the third sentence.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

Add the following Sections:

"3.3.2.1 The Contractor shall immediately remove from the Work, whenever requested to do so by the Owner, any person who is considered by the Owner or Architect to be incompetent or disposed to be so disorderly, or who for any reason is not satisfactory to the Owner, and that person shall not again be employed on the Work without the consent of the Owner or the Architect."

"3.3.4 The Contractor must provide suitable storage facilities at the Site for the proper protection and safe storage of their materials, or as otherwise identified by the specifications. Consult the Owner and the Architect before storing any materials."

"3.3.5 When any room is used as a shop, storeroom, office, etc., by the Contractor or Subcontractor(s) during the construction of the Work, the Contractor making use of these areas will be held responsible for any repairs, patching or cleaning arising from such use."

3.4 LABOR AND MATERIALS

Add the Following Sections:

"3.4.4 Before starting the Work, each Contractor shall carefully examine all preparatory Work that has been executed to receive their Work. Check carefully, by whatever means are required, to insure that its Work and adjacent, related Work, will finish to proper contours, planes and levels. Promptly notify the Architect & Owner of any defects or imperfections in preparatory Work which will in any way affect satisfactory completion of its Work. Absence of such notification will be construed as an acceptance of preparatory Work and later claims of defects will not be recognized."

"3.4.5 Under no circumstances shall the Contractor's Work proceed prior to preparatory Work having been completely cured, dried and/or otherwise made satisfactory to receive this Work. Responsibility for timely installation of all materials rests solely with the Contractor responsible for that Work, who shall maintain coordination at all times."

3.5 WARRANTY

Add the following Sections:

"3.5.3 The Contractor will guarantee all materials and workmanship against original defects, except injury from proper and usual wear when used for the purpose intended, for two years after Acceptance by the Owner, and will maintain all items in perfect condition during the period of warranty."

“3.5.4 Defects appearing during the period of warranty will be made good by the Contractor at his expense upon demand of the Owner, it being required that all work will be in perfect condition when the period of warranty will have elapsed.”

“3.5.5 Upon notification by the Owner of a defect covered by the Contractor’s warranty, the Contractor shall respond within 4 hours of the notification.”

“3.5.6 In addition to the General Warranty there are other warranties required for certain items for different periods of time than the two years as above, and are particularly so stated in that part of the specifications referring to same. The said warranties will commence at the same time as the General Warranty.”

“3.5.7 If the Contractor fails to remedy any failure, defect or damage within a reasonable time after receipt of notice, the Owner will have the right to replace, repair, or otherwise remedy the failure, defect or damage at the Contractor’s expense.”

3.8 ALLOWANCES

Add the following Section:

“3.8.1.1 For costs to be covered under a project allowance, (included in the schedule of values) the Contractor shall submit a summary of those costs anticipated and an Allowance Access Authorization Form to the Architect and Owner, reflecting the projected costs. The Allowance Access Authorization Form must be signed by the Owner prior to initiating any work associated with the allowance.”

3.10 CONTRACTOR’S CONSTRUCTION AND SUBMITTAL SCHEDULES

3.10.1 Add “estimated” after “and the” and before “date of” in the second sentence.

3.10.2 Strike “and thereafter as necessary to maintain a current submittal schedule” in the first sentence.

3.11 DOCUMENTS AND SAMPLES AT THE SITE

Add the following Sections:

“3.11.1 During the course of the Work, the Contractor shall maintain a record set of drawings on which the Contractor shall mark the actual physical location of all piping, valves, equipment, conduit, outlets, access panels, controls, actuators, including all appurtenances that will be concealed once construction is complete, etc., including all invert elevations.”

“3.11.2 At the completion of the project, the Contractor shall obtain a set of the conformed contract drawings from the Architect, and neatly transfer all information outlined in 3.11.1 to provide a complete record of the as-built conditions.”

“3.11.3 Upon completion of the work noted in 3.11.2 the contractor shall schedule a meeting with the Architect/Engineer and Owner to review the final record drawings and closeout documents prior to submission. After this meeting the Contractor shall make adjustments per the review, and submit one (1) original markup and (2) copies of the red line drawings (as-built conditions, to the Owner and one (1) print to the Architect. In addition, attach one complete set of the as-built documents to each of the Operating and Maintenance Instructions/Manuals. The Contractor will include (2) USB drives, each

containing all “red line drawings (as-built) and Closeout Documents properly tabbed in accordance with closeout requirements as defined elsewhere in the contract documents.”

3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

3.12.10.2 Strike “If the Contract Documents require” from the beginning of the sentence.

3.12.10.2 Strike “to” between “professional” and certify” and replace with “shall”.

3.17 Insert “indemnify and” between “shall” and “hold” in the second sentence.

ARTICLE 4: ADMINISTRATION OF THE CONTRACT

4.2 ADMINISTRATION OF THE CONTRACT

4.2.7 Strike the first sentence and replace with the following:

“The Architect will review and approve or take other appropriate action upon the Contractor’s submittals such as Shop Drawings, Product Data and Samples for the purpose of checking for conformance with the Contract Documents.”

4.2.7 Strike the second sentence and replace with the following:

“The Architect’s action will be taken with such reasonable promptness as to cause no delay in the Work in the activities of the Owner, Contractor or separate Contractors, while allowing sufficient time in the Owner’s professional judgment to permit adequate review.”

Add the following Section:

“4.2.10.1 There will be no full-time Project Representative provided by the Owner or Architect on this project.”

“4.2.13 Add “and in compliance with all local requirements.” to the end of the sentence.”

ARTICLE 5: SUBCONTRACTORS

5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

5.2.3 Strike Section 5.2.3 in its entirety and replace with the following:

“If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection, subject to the statutory requirements of 29 Delaware Code § 6962(d)(10)b.3 and 4.”

5.2.4 Strike Section 5.2.4 in its entirety and replace with the following:

“The Contractor may not substitute any Subcontractor listed in its Bid unless the Contractor complies with the requirements of 29 Delaware Code § 6962(d)(10)b.3 and 4. Failure to comply with this requirement shall subject the Contractor to a penalty as outlined in Section 5.2 of the Owner’s General Requirements.”

Add the following Section:

“5.2.5 The Contractor shall comply and shall ensure all Subcontractors comply with all requirements for drug testing as set forth in TITLE 19 LABOR DELAWARE ADMINISTRATIVE CODE 4000 Office of Management and Budget 4100 Division of Facilities Management **4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects.**”

ARTICLE 6: CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

- 6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS
 - 6.1.1 Strike “and waiver of subrogation” from the end of the second sentence.
 - 6.1.4 Strike Section 6.1.4 in its entirety.
- 6.2 MUTUAL RESPONSIBILITY
 - 6.2.3 Strike “shall” and replace with “may” in the second sentence.

ARTICLE 7: CHANGES IN THE WORK

(SEE ARTICLE 7: CHANGES IN WORK IN THE DELAWARE TECHNICAL AND COMMUNITY COLLEGE GENERAL REQUIREMENTS)

- 7.3.4.1 Strike “and other employee costs approved by the Architect” after “worker’s compensation insurance,”
- 7.3.4.4 Add “work attributable to the” before “change” at the end of the sentence.
- 7.4 MINOR CHANGES IN WORK
 - Add “unless such changes are approved” at the end of the third sentence.

ARTICLE 8: TIME

- 8.2 PROGRESS AND COMPLETION
 - 8.2.1 Add the following Section:
 - “8.2.1.1 Refer to Project Specifications Section SUMMARY OF WORK for Contract time requirements.”
 - 8.2.2 After “by the Contractor” strike “and” and insert “to”.
 - 8.2.4 Add the following Section:
 - “8.2.4 If the Work falls behind the Progress Schedule as submitted by the Contractor, the Contractor shall employ additional labor and/or equipment necessary to bring the Work into compliance with the Progress Schedule at no additional cost to the Owner.”

8.3 DELAYS AND EXTENSION OF TIME

8.3.1 Strike "binding dispute resolution" and insert "any and all remedies at law or in equity".

Add the following Section:

"8.3.2.1 The Contractor shall update the status of the suspension, delay, or interruption of the Work with each Application for Payment. (The Contractor shall report the termination of such cause immediately upon the termination thereof.) Failure to comply with this procedure shall constitute a waiver for any claim for adjustment of time or price based upon said cause."

Strike Section 8.3.3 in its entirety and replace with the following:

8.3.3 "Except in the case of a suspension of the Work directed by the Owner, an extension of time under the provisions of Section 8.3.1 shall be the Contractor's sole remedy in the progress of the Work and there shall be no payment or compensation to the Contractor for any expense or damage resulting from the delay."

Add the following Section:

"8.3.4 By permitting the Contractor to work after the expired time for completion of the project, the Owner does not waive their rights under the Contract."

ARTICLE 9: PAYMENTS AND COMPLETION

9.2 SCHEDULE OF VALUES

Add the following Sections:

"9.2.1 The Schedule of Values shall be submitted using AIA Document G703, Continuation Sheet to G702."

"9.2.2 The Schedule of Values is to include a line item for Project Closeout Document Submittal. The value of this item is to be no less than 1.5% of the initial contract amount."

9.3 APPLICATIONS FOR PAYMENT

9.3.1 Strike Section 9.3.1 in its entirety and replace with the following:

"At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values for completed portions of the Work. The application shall be notarized, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage."

Add the following Sections:

"9.3.1.3 Application for Payment shall be submitted on AIA Document G702 "Application and Certificate for Payment", supported by AIA Document G703 "Continuation Sheet". Said Applications shall be fully executed and notarized."

“9.3.4 Until Closeout Documents have been received and outstanding items completed the Owner will pay 95% (ninety-five percent) of the amount due the Contractor on account of progress payments.”

“9.3.5 The Contractor shall provide a current and updated Progress Schedule to the Architect with each Application for Payment. Failure to provide Schedule will be just cause for rejection of Application for Payment.”

9.5 DECISIONS TO WITHHOLD CERTIFICATION

Add the following Subsections to 9.5.1:

- .8 failure to provide a current Progress Schedule;
- .9 a lien or attachment is filed;
- .10 failure to comply with mandatory requirements for maintaining Record Documents.

9.6 PROGRESS PAYMENTS

9.6.1 Strike Section 9.6.1 in its entirety and replace with the following:

“9.6.1 After the Architect has approved and issued a Certificate for Payment, payment shall be made by the Owner within 30 days after Owner’s receipt of the Certificate for Payment.”

9.6.8 Strike “Provided the Owner has fulfilled its payment obligations under the Contract Documents,” in the first sentence.

9.7 FAILURE OF PAYMENT

Strike Section 9.7 in its entirety and replace with the following:

“If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within fourteen days after receipt of the Contractor’s Application for Payment, or if the Owner does not pay the Contractor within thirty days after the date established in the Contract Documents, the amount certified by the Architect, then the Contractor may, upon thirty additional days’ notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor’s reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.”

9.8 SUBSTANTIAL COMPLETION

9.8.3 At the end of Section 9.8.3, add the following sentence:

“If the Architect is required to make more than 2 inspections of the same portion of work, the Contractor shall be responsible for all costs associated with subsequent inspections including but not limited to any Architect’s fees.”

9.8.5 Strike “shall” and insert “may” in the second sentence.

9.8.5 Insert “1/2 of the” after “make payment of” in the second sentence.

9.9 PARTIAL OCCUPANCY OR USE

- 9.9.1 Strike the first sentence and replace with the following (the remainder of the Section remains as written):
"The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use authorized by public authorities having jurisdiction over the Project."
- 9.10.2 Strike "to remain in force after final payment is currently in effect" after "required by the Contract Documents" and replace with "shall remain in force until final payment is completed" in the first sentence.
- 9.10.4.4 Strike "if permitted by the Contract Documents,"

ARTICLE 10: PROTECTION OF PERSONS AND PROPERTY

10.1 SAFETY PRECAUTIONS AND PROGRAMS

Add the following Sections:

- 10.1.1 Each Contractor shall develop a safety program in accordance with the Occupational Safety and Health Act of 1970. A copy of said plan shall be furnished to the Owner and Architect prior to the commencement of that Contractor's Work.
- 10.1.2 Each Contractor shall appoint a Safety Representative. Safety Representatives shall be someone who is on site on a full time basis. If deemed necessary by the Owner or Architect, Contractor Safety meetings will be scheduled. The attendance of all Safety Representatives will be required. Minutes will be recorded of said meetings by the Contractor and will be distributed to all parties as well as posted in all job offices/trailers etc.

10.2 SAFETY OF PERSONS AND PROPERTY

Add the following Section:

- 10.2.4.1 As required in the Hazardous Chemical Act of June 1984, all vendors supplying any material that may be defined as hazardous must provide Material Safety Data Sheets for those products. Any chemical product should be considered hazardous if it has a caution warning on the label relating to a potential physical or health hazard, if it is known to be present in the work place, and if employees may be exposed under normal conditions or in foreseeable emergency situations. Material Safety Data Sheets shall be provided directly to the Owner, along with the shipping slips that include those products.
- 10.2.5 Strike the second sentence in its entirety.
- 10.3 HAZARDOUS MATERIALS AND SUBSTANCES
- 10.3.3 Strike Section 10.3.3 in its entirety.
- 10.3.4 Insert "hazardous" in the last sentence after "handling of such" .
- 10.3.6 Strike Section 10.3.6 in its entirety.

ARTICLE 11: INSURANCE AND BONDS

11.1 CONTRACTOR'S INSURANCE AND BONDS

11.1.1 Strike "Owner" from the third sentence .

11.2 OWNER'S LIABILITY INSURANCE

Strike 11.2 in its entirety, except that in the case of school projects in which case Section 11.2 shall remain.

11.3 WAIVERS OF SUBROGATION

Delete Section 11.3 in its entirety

11.4 LOSS OF USE, BUSINESS INTERRUPTION, AND DELAY IN COMPLETION INSURANCE

Delete Section 11.4 in its entirety

ARTICLE 12: UNCOVERING AND CORRECTION OF WORK

12.2.2 AFTER SUBSTANTIAL COMPLETION

Add the following Section:

"12.2.2.1.1 At any time during the progress of the Work, or in any case where the nature of the defects will be such that it is not expedient to have corrected, the Owner, at its option, will have the right to deduct such sum, or sums, of money from the amount of the Contract as it considers justified to adjust the difference in value between the non-conforming work and that required under contract including any damage to the structure."

12.2.2.1 Strike all references to "one year" or "one-year" and replace with "two years".

12.2.2.2 Strike "one-year" and replace with "two years".

12.2.2.3 Strike "one-year" and replace with "two years".

12.2.5 Strike "one-year" and replaced with "two years".

ARTICLE 13: MISCELLANEOUS PROVISIONS

13.1 GOVERNING LAW

Strike the last sentence.

13.4 TESTS AND INSPECTIONS

13.4.1 Strike the last sentence and replace with the following:

"The Owner shall pay for tests, inspections, or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor."

13.5 INTEREST

Strike “the date payment is due at such rate as the parties may agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located” and replace with “30 days of presentment of the authorized Certificate of Payment at the annual rate of 12% or 1% per month.”

Insert the following Section:

“13.6 CONFLICTS WITH FEDERAL STATUTES OR REGULATIONS

13.6.1 If any provision, specifications or requirement of the Contract Documents conflict or is inconsistent with any statute, law or regulation of the government of the United States of America, the Contractor shall notify the Architect and Owner immediately upon discovery.”

ARTICLE 14: TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 TERMINATION BY THE CONTRACTOR

14.1.1.4 Insert “, upon the Contractors’ request,” after “furnish to the Contractor” .

14.1.3 Strike “and profit on Work not executed, and” after “as well as reasonable overhead” and replace with “, profit, and reasonable”

14.3 SUSPENSION BY OWNER FOR CONVENIENCE

14.3.2 Strike “Adjustment of the Contract Sum shall include profit”.

14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

14.4.3 Strike Section 14.4.3 in its entirety and replace with the following:

“In case of such termination for the Owner’s convenience, the Contractor shall be entitled to receive payment for Work executed, and reasonable costs incurred by reason of such termination along with reasonable overhead.”

ARTICLE 15: CLAIMS AND DISPUTES

15.1 CLAIMS

15.1.2 TIME LIMITS ON CLAIMS

Strike the last sentence.

15.1.3 NOTICE OF CLAIM

Strike all references to “21” and replace with “45”.

15.1.5 CLAIMS FOR ADDITIONAL COSTS

Strike the first sentence and replace with the following:

“Contractor shall not proceed to execute any portion of the Work that is subject to the Claim without prior approval of the costs or method of payment for the costs associated with the Claim as determined by the Architect and approved by the Owner.”

15.1.7 WAIVER OF CLAIMS FOR CONSEQUENTIAL DAMAGES

Strike Section 15.1.7 in its entirety.

15.2 INITIAL DECISION

15.2.1 Strike “and binding dispute resolution” in the fourth sentence and replace with “or any and all remedies at law or in equity”.

15.2.5 Strike Section 15.2.5 in its entirety and replace with the following:

“The Architect will approve or reject Claims by written decision, which shall state the reasons therefore and shall notify the parties of any change in the Contract Sum or Contract Time or both. The approval or rejection of a Claim by the Architect shall be subject to mediation and any or all remedies at law or in equity.”

15.2.6 Strike Section 15.2.6 and its subsections in their entirety.

15.3 MEDIATION

15.3.1 Strike “binding dispute resolution” and replace with “any or all remedies at law or in equity”.

15.3.2 Strike “, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedure in effect on the date of the Agreement,” in the first sentence.

15.3.2 Strike all references to “binding dispute resolution” and replace with “any or all remedies at law and in equity”.

15.3.3 Strike Section 15.3.3 in its entirety.

15.4 ARBITRATION

Strike Section 15.4 and its Subsections in their entirety.

END OF SUPPLEMENTARY GENERAL CONDITIONS

STATE OF DELAWARE
OFFICE OF MANAGEMENT AND BUDGET

PERFORMANCE BOND

Bond Number: _____

KNOW ALL PERSONS BY THESE PRESENTS, that we, _____, as principal (“**Principal**”), and _____, a _____ corporation, legally authorized to do business in the State of Delaware, as surety (“**Surety**”), are held and firmly bound unto the _____ (“**Owner**”) (*insert State agency name*), in the amount of _____ (\$_____), to be paid to **Owner**, for which payment well and truly to be made, we do bind ourselves, our and each and every of our heirs, executors, administrations, successors and assigns, jointly and severally, for and in the whole, firmly by these presents.

Sealed with our seals and dated this _____ day of _____, 20__.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH, that if **Principal**, who has been awarded by **Owner** that certain contract known as Contract No. _____ dated the _____ day of _____, 20__ (the “Contract”), which Contract is incorporated herein by reference, shall well and truly provide and furnish all materials, appliances and tools and perform all the work required under and pursuant to the terms and conditions of the Contract and the Contract Documents (as defined in the Contract) or any changes or modifications thereto made as therein provided, shall make good and reimburse **Owner** sufficient funds to pay the costs of completing the Contract that **Owner** may sustain by reason of any failure or default on the part of **Principal**, and shall also indemnify and save harmless **Owner** from all costs, damages and expenses arising out of or by reason of the performance of the Contract and for as long as provided by the Contract; then this obligation shall be void, otherwise to be and remain in full force and effect.

Surety, for value received, hereby stipulates and agrees, if requested to do so by **Owner**, to fully perform and complete the work to be performed under the Contract pursuant to the terms, conditions and covenants thereof, if for any cause **Principal** fails or neglects to so fully perform and complete such work.

Surety, for value received, for itself and its successors and assigns, hereby stipulates and agrees that the obligation of **Surety** and its bond shall be in no way impaired or affected by any extension of time, modification, omission, addition or change in or to the Contract or the work to be performed thereunder, or by any payment thereunder before the time required therein, or by any waiver of any provisions thereof, or by any assignment, subletting or other transfer thereof or of any work to be performed or any monies due or to become due thereunder; and **Surety** hereby waives notice of any and all such extensions, modifications, omissions, additions, changes, payments, waivers, assignments, subcontracts and transfers and hereby expressly stipulates and agrees that any and all things done and omitted to be done by and in relation to assignees, subcontractors, and other

transferees shall have the same effect as to **Surety** as though done or omitted to be done by or in relation to **Principal**.

Surety hereby stipulates and agrees that no modifications, omissions or additions in or to the terms of the Contract shall in any way whatsoever affect the obligation of **Surety** and its bond.

Any proceeding, legal or equitable, under this Bond may be brought in any court of competent jurisdiction in the State of Delaware. Notices to **Surety** or Contractor may be mailed or delivered to them at their respective addresses shown below.

IN WITNESS WHEREOF, **Principal** and **Surety** have hereunto set their hand and seals, and such of them as are corporations have caused their corporate seal to be hereto affixed and these presents to be signed by their duly authorized officers, the day and year first above written.

PRINCIPAL

Name: _____

Witness or Attest: Address: _____

Name:

(Corporate Seal)

By: _____ (SEAL)
Name:
Title:

SURETY

Name: _____

Witness or Attest: Address: _____

Name:

(Corporate Seal)

By: _____ (SEAL)
Name:
Title:

STATE OF DELAWARE
OFFICE OF MANAGEMENT AND BUDGET

PAYMENT BOND

Bond Number: _____

KNOW ALL PERSONS BY THESE PRESENTS, that we, _____, as principal (“**Principal**”), and _____, a _____ corporation, legally authorized to do business in the State of Delaware, as surety (“**Surety**”), are held and firmly bound unto the _____ (“**Owner**”) (*insert State agency name*), in the amount of _____ (\$_____), to be paid to **Owner**, for which payment well and truly to be made, we do bind ourselves, our and each and every of our heirs, executors, administrations, successors and assigns, jointly and severally, for and in the whole firmly by these presents.

Sealed with our seals and dated this _____ day of _____, 20__.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH, that if **Principal**, who has been awarded by **Owner** that certain contract known as Contract No. _____ dated the _____ day of _____, 20__ (the “Contract”), which Contract is incorporated herein by reference, shall well and truly pay all and every person furnishing materials or performing labor or service in and about the performance of the work under the Contract, all and every sums of money due him, her, them or any of them, for all such materials, labor and service for which **Principal** is liable, shall make good and reimburse **Owner** sufficient funds to pay such costs in the completion of the Contract as **Owner** may sustain by reason of any failure or default on the part of **Principal**, and shall also indemnify and save harmless **Owner** from all costs, damages and expenses arising out of or by reason of the performance of the Contract and for as long as provided by the Contract; then this obligation shall be void, otherwise to be and remain in full force and effect.

Surety, for value received, for itself and its successors and assigns, hereby stipulates and agrees that the obligation of **Surety** and its bond shall be in no way impaired or affected by any extension of time, modification, omission, addition or change in or to the Contract or the work to be performed thereunder, or by any payment thereunder before the time required therein, or by any waiver of any provisions thereof, or by any assignment, subletting or other transfer thereof or of any work to be performed or any monies due or to become due thereunder; and **Surety** hereby waives notice of any and all such extensions, modifications, omissions, additions, changes, payments, waivers, assignments, subcontracts and transfers and hereby expressly stipulates and agrees that any and all things done and omitted to be done by and in relation to assignees, subcontractors, and other transferees shall have the same effect as to **Surety** as though done or omitted to be done by or in relation to **Principal**.

Surety hereby stipulates and agrees that no modifications, omission or additions in or to the terms of the Contract shall in any way whatsoever affect the obligation of **Surety** and its bond.

Any proceeding, legal or equitable, under this Bond may be brought in any court of competent jurisdiction in the State of Delaware. Notices to **Surety** or Contractor may be mailed or delivered to them at their respective addresses shown below.

IN WITNESS WHEREOF, **Principal** and **Surety** have hereunto set their hand and seals, and such of them as are corporations have caused their corporate seal to be hereto affixed and these presents to be signed by their duly authorized officers, the day and year first above written.

PRINCIPAL

Name: _____

Witness or Attest: Address: _____

Name:

(Corporate Seal)

By: _____(SEAL)
Name:
Title:

SURETY

Name: _____

Witness or Attest: Address: _____

Name:

(Corporate Seal)

By: _____(SEAL)
Name:
Title:



REPORT OF SUBSURFACE EXPLORATION

DelTech Automotive Center

Georgetown
Sussex County, Delaware

April 5, 2019

Prepared For:

Becker Morgan Group, Inc.
312 W. Main Street, Suite 300
Salisbury, Maryland 21801

Attn: Mr. Ellis F. Hammond, A.I.A.

Prepared By:

GEO-TECHNOLOGY ASSOCIATES, INC.
Geotechnical and Environmental Consultants
21133 Sterling Avenue, Suite 7
Georgetown, Delaware 19947
302-855-9761 / Fax 302-856-3388

GTA Job No: 31190200

GEO-TECHNOLOGY ASSOCIATES, INC.

GEOTECHNICAL AND
ENVIRONMENTAL CONSULTANTS

A Practicing Geoprofessional Business Association Member Firm



April 5, 2019

Becker Morgan Group, Inc.
312 W. Main Street, Suite 300
Salisbury, Maryland 21801

Attn: Mr. Ellis F. Hammond, A.I.A.
Senior Associate


Re: Report of Subsurface Exploration
DelTech Automotive Center
Georgetown
Sussex County, Delaware


Ladies & Gentlemen:

Pursuant to your request, Geo-Technology Associates, Incorporated (GTA) has performed geotechnical exploration at the ***DelTech Automotive Center*** located in Georgetown, Delaware. The purpose of the subsurface exploration was to present our recommendations regarding earthwork, foundation, slab support of the proposed building and pavement cross-sections, and evaluate the suitability of subsoils for potential infiltration for stormwater management facilities.

Unless Becker Morgan Group, Inc. specifies otherwise, the samples collected as a part of the subsurface exploration will be disposed of after a period of 60 days from the date of this report. Thank you for the opportunity to be of assistance. If you have any questions or require additional information, please do not hesitate to contact our office.

Sincerely,
GEO-TECHNOLOGY ASSOCIATES, INC.


for
Travis P. Caraway, EIT
Staff Geotechnical Professional


Gregory R. Sauter, P.E.
Vice President



TPC/GRS/llh 31190200

21133 Sterling Avenue, Suite 7, Georgetown, DE 19947 (302) 855-9761 Fax: (302) 856-3388

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REPORT OF SUBSURFACE EXPLORATION

DELTECH AUTOMOTIVE CENTER GEORGETOWN SUSSEX COUNTY, DELAWARE APRIL 2019

INTRODUCTION

A new Automotive Center is proposed at the Delaware Technical Community College (DelTech) – Owens Campus located in Georgetown, Delaware. Geo-Technology Associates, Inc. (GTA) was retained by Becker Morgan Group, LLC to perform a geotechnical exploration of the site. The scope of this study included field exploration, review of site plans, limited laboratory testing and engineering analysis. The field exploration consisted of nine Standard Penetration Test (SPT) borings, performed within the proposed building, stormwater management and pavement areas. Plans titled *DTCC Automotive Center Soil Boring Location Plan*, prepared by Becker Morgan Group (BMG) and dated May 18, 2017, was referenced for this report.

SITE CONDITIONS

Referring to the Site Location Plan and the Exploration Location Plan included as Figures 1 and 2, respectively, in Appendix A, the Owens Campus is located on the south side of Seashore Highway (DE Route 404) and east of Vaughn Road. The site is located within an existing parking lot at the southwest corner of the campus grounds. The project area is relatively level with the ground surface at the exploration locations generally ranges between Elevation 46 and Elevation 48 Mean Sea Level (MSL). A drainage swale, with an invert at approximate Elevation 41 MSL, runs along the east edge of the project area.

PROPOSED CONSTRUCTION

The proposed construction will consist of one-story, slab-on grade building. A shallow spread foundation system and ground supported slabs are anticipated. Preliminary foundation loads of upwards to 150 kips for columns and 5 kips per lineal foot are estimated for the proposed structures. Once final loads are determined, GTA should be consulted for additional analysis and recommendations, as applicable.

Two porous paver (PAVE Drain™) stormwater management (SWM) facilities are proposed within the parking area on the east side of the proposed building. The building will be served by public water and sewer. Proposed grades should closely match existing grades.

SITE GEOLOGY

According to the Geologic Map of Georgetown Quadrangle Delaware, Series 15 (2010) published by the Delaware Geological Survey, the site is within the Coastal Plain Physiographic Province. Coastal Plain sediments below the surficial deposits exposed in the site area were generally deposited in commonly estuarine environments of Tertiary geologic age. The Pliocene deposits are designated as the Beaverdam Formation. Sediments of the Beaverdam Formation typically consist of "... medium sands with some beds of coarse gravelly sands and... silty clay." Please refer to the publications for additional information.

SUBSURFACE EXPLORATION

The field exploration consisted of nine Standard Penetration Test (SPT) borings, designated as B-1 through B-4 within the proposed building footprint, S-1 and S-2 within the proposed pavement areas and as I-1 through I-3 within the proposed pavement/SWM area. These borings were performed during March 2019, to depths of approximately 5 to 25 feet below the existing ground surface. An ATV mounted CME-55 drill rig was used to drill the SPT borings.

The borings were performed at the approximate locations shown on the Exploration Location Plan, presented as Figure 2 in Appendix A. BMG selected the boring locations and GTA field located the exploration locations by tape-measuring off of existing site features. The exploration locations indicated on the plan should be considered approximate. The ground surface elevations at the explorations were estimated from a plan titled *DTCC Automotive Center Soil Boring Location Plan*, prepared by Becker Morgan Group (BMG) and dated May 18, 2017.

Standard Penetration Testing was performed in the SPT boreholes, with soil samples obtained at 2-foot intervals in the upper 10 feet and then at 5-foot intervals thereafter. Standard Penetration Testing involves driving a 2-inch O.D., 1 3/8 -inch I.D. split-spoon sampler with a 140-

pound hammer free-falling 30 inches. The SPT N-value, given as blows per foot (bpf), is defined as the total number of blows required to drive the sampler from the 6 to 18 inches below the sampling depth. Longer term water level readings were recorded one to five days after completion. Borings were backfilled after completion of the water readings.

Six, single ring, 5-inch diameter, falling head infiltration tests were also performed at locations offset from Borings I-1 through I-3 at the locations shown on the *Exploration Location Plan*. Infiltration tests performed in general accordance with *Delaware Post Construction Stormwater BMP Standards & Specifications* dated February 2019.

Samples obtained from the borings were returned to GTA's office for visual classification by GTA personnel. Selected samples recovered from the field exploration were submitted for limited laboratory analysis. The soil layers were classified in accordance with the Unified Soil Classification System (USCS) and/or the American Association of State Highway and Transportation Officials (AASHTO) classification system. Classifications provided on the logs are visual descriptions, supplemented by available laboratory data. The exploration logs are presented in Appendix B. The logs represent our interpretation of the field data based on observation and limited soil classification tests. The interfaces indicated on the logs may be gradual.

SUBSURFACE CONDITIONS

The explorations generally confirm the description of subsurface conditions provided in the *SITE GEOLOGY* section of this report. Borings B-1 through B-4 and I-1 through I-3 were in lawn areas and grass islands and encountered a 6 to 12-inch thick topsoil layer. Borings S-1 and S-2 were in existing paved areas and encountered a pavement thickness section of approximately 4-inches asphalt with an underlying aggregate subbase of approximately 8-inches thick.

At Boring B-4, fill was encountered below the topsoil extending to an approximate depth of 6 feet below the ground surface at B-4. The fill at B-4 is comprised of Silty SANDs (USCS SM; AASHTO A-4) to Poorly-graded SANDs with Silt (SP-SM; A-1, A-3) with interspersed organic

matter. The relative densities of the granular fill were medium dense based on SPT N-values of 11 to 12 blows per foot (bpf).

Below the topsoil/fill layer and pavement layer, the explorations generally encountered native soils visually classified as consisting of Poorly-graded SANDs (SP; A-1), Poorly-graded SANDs with Silt (SP-SM; A-1, A-3), Silty SANDs (SM; A-2, A-4), Clayey SANDs (SC; A-2/A-6) and Lean CLAYs (CL; A-6). The relative densities of the granular soils of the SPT borings were very loose to very dense based on SPT N-values of 3 to 54 bpf. The relative densities of the fine-grained soils were stiff based on SPT N-values of 9 to 15 bpf.

Water was encountered at completion at Borings B-1 through B-4 and I-1 through I-3 at depths of 3 to 10½ feet below the ground surface. Borings S-1 and S-2 were dry to depths of 5 feet below the ground surface at completion. Longer term water levels recorded one to five days after completion ranged between 4.3 and 6.9 feet below the existing ground surface. The longer-term water levels correspond to approximate Elevation 40 to 43 Mean Sea Level (MSL).

GTA’s estimate of the seasonal high groundwater level is based upon water levels at relative normal seasonal high levels at the time of exploration; and soil coloring and mottling. The results of the groundwater level readings and GTA’s opinion of the estimated seasonal high groundwater depth are summarized as follows:

GROUNDWATER DATA SUMMARY

Exploration No.	*Existing Ground Surface Elevation (MSL)	Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Water at Completion	Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Water At One to Five Days After Completion	**Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Estimated Seasonal High Groundwater
B-1	EL 48	10.2 / EL 37.8	4.7 / EL 43.3	5 / EL 43
B-2	EL 48	10.5 / EL 37.5	4.7 / EL 43.3	5 / EL 43
B-3	EL 49	7.0 / EL 42.0	6.9 / EL 42.1	7 / EL 42
B-4	EL 48	7.9 / EL 40.1	5.1 / EL 42.9	5 / EL 43
I-1	EL 46	6.0 / EL 40.0	6.1 / EL 39.9	6 / EL 40

Exploration No.	*Existing Ground Surface Elevation (MSL)	Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Water at Completion	Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Water At One to Five Days After Completion	**Depth Below Existing Ground Surface (ft.)/ Elevation (MSL) to Estimated Seasonal High Groundwater
I-2	EL 46	7.2 / EL 38.8	4.3 / EL 41.7	4 / EL 42
I-3	EL 47	3.0 / EL 44.0	4.7 / EL 42.3	5 / EL 42

* Existing Elevations estimated from a plan titled *Existing Conditions and Demolition Plan* prepared by Becker Morgan Group and revised dated December 14, 2017

** Seasonal high groundwater estimate based upon observed soil mottling and color, and should be considered approximate.

The groundwater levels can be expected to fluctuate with seasonal changes, precipitation, and other factors such as development activity. Additionally, perched water conditions develop in granular soils overlying fine-grained and/or denser soils during the “wet season” and during heavy periods of precipitation. Please refer to the exploration logs provided in Appendix B for further information. Idealized subsurface profiles are shown on Figure Nos. 3 through 4 in Appendix A.

Six, single ring, 5-inch diameter, falling head infiltration tests were performed at locations offset from Borings I-1 through I-3, at the relative locations shown on the *Exploration Location Plan*. The infiltration test holes were pre-soaked prior to the falling head tests. Each test location was charged with a six-inch head and the water level drop was recorded at 15 minutes or less intervals. The results of the six infiltration tests, test depths, estimated seasonal high groundwater, soil type at each test location, and our opinion of infiltration suitability are summarized as follows:

SUMMARY OF INFILTRATION DATA

TEST NO.	EXISTING GROUND SURFACE ELEVATION (MSL)	*DEPTH BELOW EXISTING GROUND SURFACE (FT)/ ELEVATION (MSL) TO ESTIMATED SEASONAL HIGH GROUNDWATER	INFILTRATION TEST DEPTH BELOW EXISTING GROUND SURFACE (FT)/ ELEVATION (MSL)	**INFILTRATION TEST INFILTRATION RATE (IN/HR)	ESTIMATED VISUAL USDA SOIL CLASSIFICATION	POTENTIAL INFILTRATION SUITABILITY
I-1	46	6 / EL 40	1.6 / 44.4	0	Medium Dense Loamy Sand	No
I-2	46	4 / EL 42	1.6 / 44.4	19.2	Loose Loamy Sand to Sand	Yes
I-3	47	5 / EL 42	1.6 / 45.4	24.0	Loose Sand	Yes

TEST NO.	EXISTING GROUND SURFACE ELEVATION (MSL)	*DEPTH BELOW EXISTING GROUND SURFACE (FT)/ ELEVATION (MSL) TO ESTIMATED SEASONAL HIGH GROUNDWATER	INFILTRATION TEST DEPTH BELOW EXISTING GROUND SURFACE (FT)/ ELEVATION (MSL)	**INFILTRATION TEST INFILTRATION RATE (IN/HR)	ESTIMATED VISUAL USDA SOIL CLASSIFICATION	POTENTIAL INFILTRATION SUITABILITY
I-1	46	6 / EL 40	2.1 / 43.9	19.2	Loose Loamy Sand to Sand	Yes
I-2	46	4 / EL 42	2.1 / 43.9	0.72	Medium Dense Loamy Sand	No
I-3	47	5 / EL 42	2.1 / 44.9	30+	Loose Loamy Sand to Sand	Yes

*Seasonal high groundwater estimate based upon observed soil mottling and color, and should be considered approximate.

** Infiltration tests performed in general accordance with ASTM D-5126.

LABORATORY TESTING

A selected sample obtained from the borings was tested for grain-size analysis, Atterberg Limits, moisture density relationships, California Bearing Ratio (CBR) and natural moisture content. The grain-size analysis and Atterberg Limits testing were performed to identify the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) designations for the soil. The results of testing are as follows:

SUMMARY OF LABORATORY TESTING

EXPLORATION NO.	DEPTH (FT.)	USCS CLASSIFICATION	AASHTO CLASSIFICATION	LL (%)	PI (%)	NM %
B-4	1 – 4	Silty SAND (SM)	A-4 (0)	NP	NP	14.1

Note: LL=Liquid Limit PI=Plastic Index NP=Non-plastic NM=Natural Moisture Content

The bulk, near-surface sample was also tested for moisture-density relationships in accordance with the Modified Proctor (ASTM D-1557) method for use in evaluating the suitability of these soils for reuse as fill. The same sample was also subjected to California Bearing Ratio (CBR) testing for use in evaluation of pavement subgrade supporting quality. Results of these tests are summarized in the following table.

**SUMMARY OF COMPACTION and CBR DATA
(ASTM D 1557, the Modified Proctor; ASTM D 1883, CBR)**

EXPLORATION NO.	DEPTH (FT)	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE (%)	NATURAL MOISTURE (%)	CBR AT 95% COMPACTION (%)
B-4	1 - 4	131.0	7.6	14.1	7.2

Please refer to the laboratory test results included within Appendix C for additional information.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of this study, it is our opinion that construction of the proposed improvements is feasible, given that the geotechnical recommendations are followed and that the standard level of care is maintained during construction. GTA's preliminary recommendations are provided in the following paragraphs.

Earthwork

Before the placement of compacted fill, areas below proposed foundations, slabs, and pavements should be stripped to remove debris, topsoil, organic matter, soft materials and existing asphalt to be abandoned. After stripping, subgrade areas should be proof-rolled with a loaded tandem-axle dump truck, performed as recommended by GTA. Within the proposed building footprint oversized by 5 feet on all sides, further remove existing fill materials and replace with structural fill. Existing fill was encountered at Boring B-4 extending to a depth of 6 feet. The actual depth and location of existing fill may vary across the site. No fill should be placed until the geotechnical engineer approves the subgrade. Wet soils near surface grade will result in poor trafficability. Positive drainage should be maintained during construction.

Most near surface on-site soils beneath the topsoil and existing pavement, similar to the materials tested are considered suitable for reuse as structural fill material. Excavated site materials conforming to SP, SP-SM, SC or SM classifications will be suitable for reuse as structural utility backfill and in structural areas of earthwork construction. The moisture of the bulk sample was approximately 6 percent above the optimum moisture content. At this indicated moisture level,

granular site materials similar to the sample tested will require drying by aeration after spreading and prior to compaction to achieve the project compaction specifications. During wet weather or when excavating below or near groundwater, delays and expense will likely be associated with reducing soil moistures to acceptable levels.

For utility and site earthwork construction, the success of these operations will be largely dependent upon the weather conditions at the time of the earthwork construction. Summer construction season is recommended to reduce the premium cost for drying. A contingency should be established for moisture adjustments and importing suitable materials. If the work is performed during wet weather, offsite borrow may be required to complete the earthwork construction.

Deeper excavations, such as for utility installations, will likely encounter groundwater. Consideration must be given to dewatering and stability of excavated slopes. Contractors should provide adequate dewatering and earth support systems in utility trench excavations. Utility pipe systems below pavement and other structural areas should be backfilled using controlled, compacted fill. The backfill should be constructed as described in our site grading recommendations. Lift thickness should be reduced to 4 inches when compacting with lightweight equipment around structures. Excavated Clays (CL) or Silts (ML) are not recommended for reuse as backfill and should be disposed of properly offsite.

Off-site borrow, if required, should meet Unified Soil Classification System (USCS) designation SM, SP, SW, GM, GP, or GW and be approved by GTA. All fills should be constructed in maximum 8-inch thick loose lifts and be compacted to the following specifications:

COMPACTION SPECIFICATIONS

Structure / Fill Location	Compaction / Moisture Specification
Below foundations, floor slab subgrades and within wall backfill and pavement areas	95% of ASTM D 1557 Moisture: ± 3% of optimum
Lawn or unimproved areas	90% of ASTM D 1557 Moisture: optimum to ± 3% of optimum

A full time soils-technician under guidance of GTA should observe fill construction. Compactive effort should be verified by in-place density testing.

Foundations

Based upon the exploration data, it is GTA's opinion that the proposed buildings may be supported on structural fill or firm native soils using shallow spread footings designed for a maximum net allowable bearing pressure of 3,000 pounds per square foot (psf). Minimum widths for wall footings of 16 inches and column footings of 24 inches are recommended. Settlement of 1-inch total and ½-inch differential over a 50-foot horizontal span is estimated considering preliminary wall loads of 5 kips per foot and column loads of 150 kips. Exterior footings should be founded a minimum of 24 inches below the final exterior grades to provide protection from frost action.

Detailed foundation evaluations should be performed in each footing excavation prior to the placement of reinforcing steel or concrete. These evaluations should be performed by a representative of GTA to confirm that the allowable soil bearing capacity is available. The foundation bearing surface evaluations should be performed using a combination of visual observation, comparison with the borings, hand-rod probing, and Dynamic Cone Penetrometer (DCP) testing. Footings should be concreted on the day they are excavated. If very loose or unsuitable fill materials are encountered, the footing excavations should be undercut and the subgrade should be reestablished with AASHTO No. 57 crushed stone or in accordance with GTA's recommendations in the field at the time of construction.

Floor Slabs

The ground floors should be designed as concrete slab-on-grade. GTA recommends that the concrete floor slabs supported on grade be founded on a four-inch thick open-graded stone layer covered with a polyethylene vapor retarder to interrupt the rise of moisture through the slab. Natural and compacted fill subgrades for support of the floor slabs should be tested to verify stability and compaction in accordance with GTA's earthwork recommendations prior to

placement of concrete. Control joints should be provided to control shrinkage cracking of the concrete floor system. Isolation joints should be present at the location of walls, columns, and footings to allow for differential movement. A modulus of subgrade reaction value of 150 psi per inch is recommended for the design of the building slabs.

Pavements

Pavement sections should be designed based on anticipated subgrade conditions and traffic intensity. Laboratory testing of selected site soils indicated a CBR value of approximately 7 percent for the silty SAND (AASHTO A-4) sample tested. The CBR value is based upon a relative compaction of 95 percent of maximum dry density (Modified Proctor, ASTM D-1557). Based upon the CBR value and the field conditions encountered at the borings, the site soils tested are considered to be generally fair to good for supporting standard pavement sections. In areas where existing and proposed parking lot areas coincide, an approximate 1¼-inch thick mill and overlay may be considered in areas where the pavement is intact and is 3½-inches or more in thickness. While the asphalt thickness encountered at the borings was approximately 4 inches, some localized areas of the parking lot had failed areas with approximately 1-inch thick asphalt.

Based on GTA's experience with similar projects, construction traffic is likely to be more significant for the design of the pavements. The pavement section thickness should be designed to reflect construction traffic and the subgrade supporting quality of the site soils. It is likely that the majority of the on-site soils will be suitable for the support of the pavement thickness sections indicated in the following paragraphs. However, subgrade materials should be carefully evaluated prior to graded aggregate base placement and paving. Subgrade materials conforming to USCS CL or ML should be undercut and replaced with suitable granular materials. Therefore, GTA recommends that the upper 12 inches of roadway subgrade be constructed of fill with the following characteristics:

PAVEMENT SUBGRADE SPECIFICATIONS

Liquid Limit	35 or less
Plasticity Index	Non-Plastic
Maximum Dry Density	105 pcf or greater
California Bearing Ratio	7 or greater

Prior to construction of pavement sections, the pavement subgrade should be proof-rolled with a loaded tandem-axle dump truck under the observation of GTA to verify stability. Unstable or unsuitable soils should be over-excavated to a stable bearing layer. The subgrade may be re-established with approved, controlled, compacted stabilized fill. A contingency for undercutting and replacement of unsuitable materials should be provided.

For parking lot pavement construction, it is recommended that two different pavement sections be utilized to reduce the potential for pavement failures during construction. The heavy-duty pavement section can be constructed for the main driveways connecting the parking lot to the roadways surrounding the project. The standard-duty pavement section can be constructed in the parking lots. It is recommended that construction traffic be limited to the heavy-duty pavement sections. The recommended preliminary pavement sections are as follows:

FLEXIBLE PAVEMENT

Pavement Components	Standard-Duty	Heavy-Duty
Bituminous Concrete Surface Course (Type C; 9.5 mm Superpave)	1 ¼ inches	1 ¼ inches
Bituminous Concrete Intermediate Course (Type C)*	--	1 ¼ inches
Bituminous Concrete Base Course (Type B; 12.5 or 19 mm Superpave)	3 inches	3 inches
Graded Aggregate Base Course (Type B Crusher Run)	6 inches	7 inches
Approved Subgrade	12 inches	12 inches

FLEXIBLE PAVEMENT OVERLAY

Pavement Components	Standard-Duty	Heavy-Duty
Bituminous Concrete Surface Course (Type C; 9.5 mm Superpave)	1 ¼ inches	1 ¼ inches
Approved Milled Existing Asphalt Pavement	-	-

RIGID PAVEMENT

Pavement Components	Standard-Duty	Heavy-Duty
Portland Cement Concrete*	5 inches	6 inches
Graded Aggregate Base Course (Type B Crusher Run)	4 inches	4 inches
Approved Subgrade	12 inches	12 inches

*f_c= 4,000 psi concrete provided with 7% air-entrainment; control joints, isolation joints, load transfer devices, and reinforcement as required.

When pavement areas are established to approximate pavement subgrade, the pavement subgrade material should be observed by GTA to allow for additional recommendations based upon subgrade conditions observed at the time of construction. All pavement materials and construction should conform to the State of Delaware, Department of Transportation (DelDOT), STANDARD SPECIFICATIONS, latest edition, and the Town of Georgetown standards, as applicable.

Stormwater Management Facilities

The guidelines established in the *Delaware Post Construction Stormwater BMP Standards & Specifications*, dated February 2019 indicate that the minimum infiltration rate for all runoff reduction and infiltration practices is one-inch per hour. Also, a vertical separation of at least two-feet from the seasonal high groundwater elevation or limiting layer is required for all infiltration practices unless an underdrain is provided.

Based on our observations made during the subsurface exploration, it is our opinion that managing stormwater quality through the use of infiltration practices is generally feasible. GTA recommends placing the facility bottoms through medium dense soils and into loose Loamy Sand

to Sand layers. A facility bottom between Elevation 45 and 44 MSL is recommended for design. To facilitate placement in loose Loamy Sand and Sand layers, the actual facility bottom elevation may vary and should be adjusted as required in the field based upon the observed conditions at the time of construction.

Field testing indicated infiltration rates of 19 to 30+ inches per hour and corresponding to an average infiltration rate of 23 inches per hour for the loose Loamy Sand and Sand layers tested; however, we recommend that a design infiltration rate of no more than 25 to 50-percent of the field measured rate for the test locations and depths be used for the final design of the facilities. This recommendation is based on the inherent problems associated with these systems as they become less permeable due to densification during construction and partial clogging or siltation occurring over time. Also, considering interspersed limiting layers encountered at the borings, GTA recommends the infiltration facilities incorporate an underdrain daylighted to the drainage swale along the east side of the project.

GTA recommends that the infiltration facilities be excavated using a track-mounted excavator, which will generally eliminate the need to operate equipment directly on the subgrade. If underground facilities are used, the subgrade should be hand cleaned using a shovel to remove any disturbed soil prior to placing the foundation stone below the chambers.

ADDITIONAL SERVICES

We recommended that during construction of the subject project, GTA be retained to provide observation and testing services for the following items.

- Review of final grades, structural loads and construction plans when established to evaluate if they conform with the intent of this report.
- Provide testing observation and services during fill placement to evaluate if the work is being performed in accordance with the project specifications and intent of this report.
- Observe the proof-rolling of pad and pavement subgrades prior to placing fill or base course to evaluate stability.

- Review excavated footings for compliance with the project drawings and the intent of this geotechnical report.
- Provide “special inspection” services during building construction for compliance with building code requirements.
- Provide post-construction infiltration testing and observe groundwater depth within proposed SWM facilities and report the results to BMG for conformance with the facility design parameters.

LIMITATIONS

This report, including all supporting exploration logs, field data, field notes, laboratory test data, calculations, estimates, and other documents prepared by GTA in connection with this project, has been prepared for the exclusive use of Becker Morgan Group, LLC pursuant to the agreements between GTA and Becker Morgan Group, LLC dated November 2, 2018 and February 19, 2019 and in accordance with generally accepted engineering practice. All terms and conditions set forth in the Agreement and the General Provisions attached thereto are incorporated herein by reference. No warranty, express or implied, is given herein. Use and reproduction of this report by any other person without the expressed written permission of GTA and Becker Morgan Group, LLC is unauthorized and such use is at the sole risk of the user.

The analysis and preliminary recommendations contained in this report are based on the data obtained from limited observation and testing of the encountered materials. Test borings indicate soil conditions only at specific locations and times and only at the depths penetrated. They do not necessarily reflect strata or variations that may exist between test boring locations. Consequently, the analysis and recommendations must be considered preliminary until the subsurface conditions can be verified by direct observation at the time of construction. If variations of subsurface conditions from those described in this report are noted during construction, recommendations in this report may need to be re-evaluated.

In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing. Geo-

Technology Associates, Inc. is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or reuse of the subsurface data or engineering analysis without the expressed written authorization of Geo-Technology Associates, Inc.

The scope of our services for this geotechnical exploration did not include any environmental assessment or investigation for the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the logs regarding odors or unusual or suspicious items or conditions observed are strictly for the information of our Client. This report and the attached logs are instruments of service. The subject matter of this report is limited to the facts and matters stated herein. Absence of a reference to any other conditions or subject matter shall not be construed by the reader to imply approval by the writer.

31190200

GEO-TECHNOLOGY ASSOCIATES, INC.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

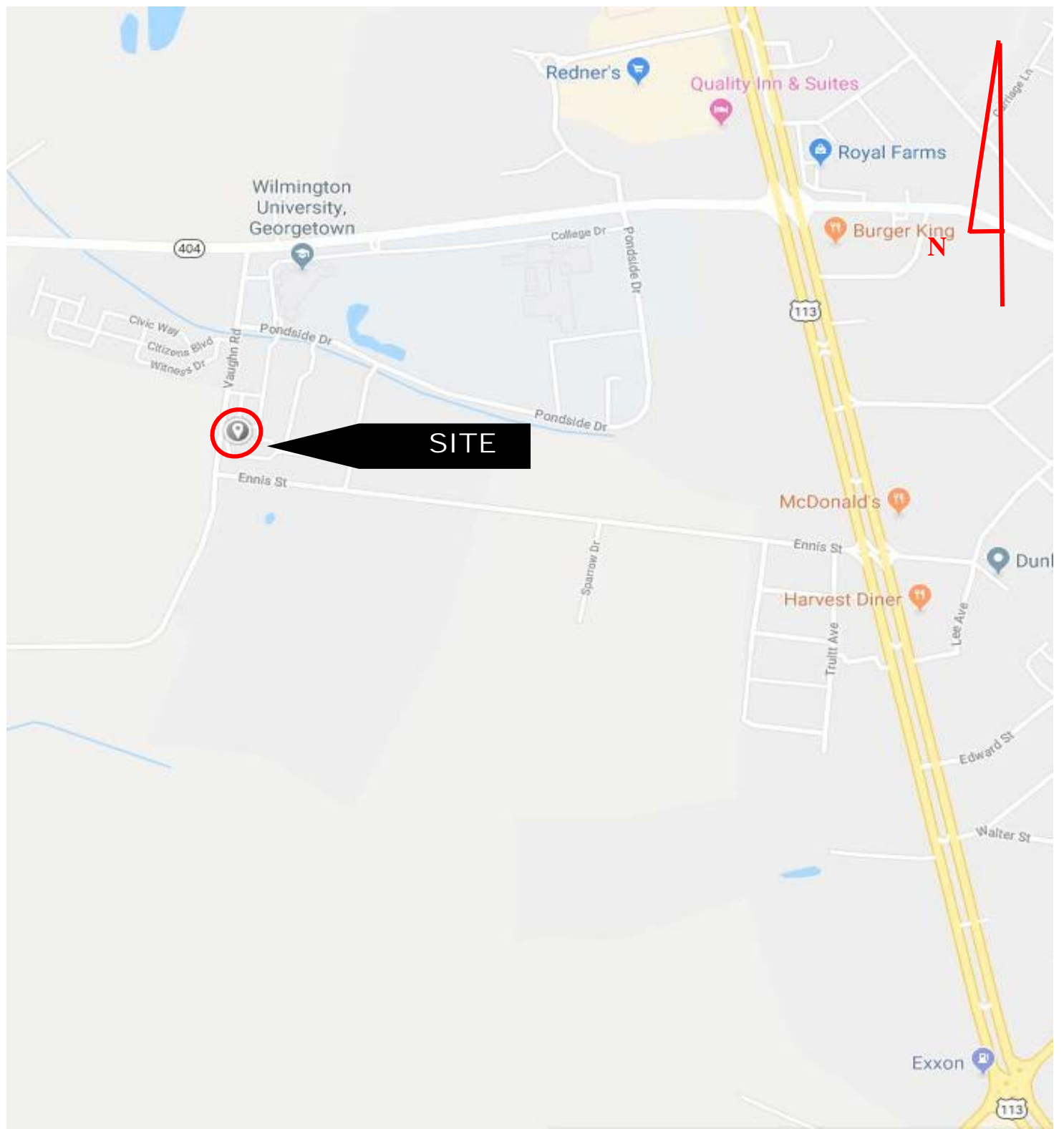
While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



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APPENDIX A
FIGURES



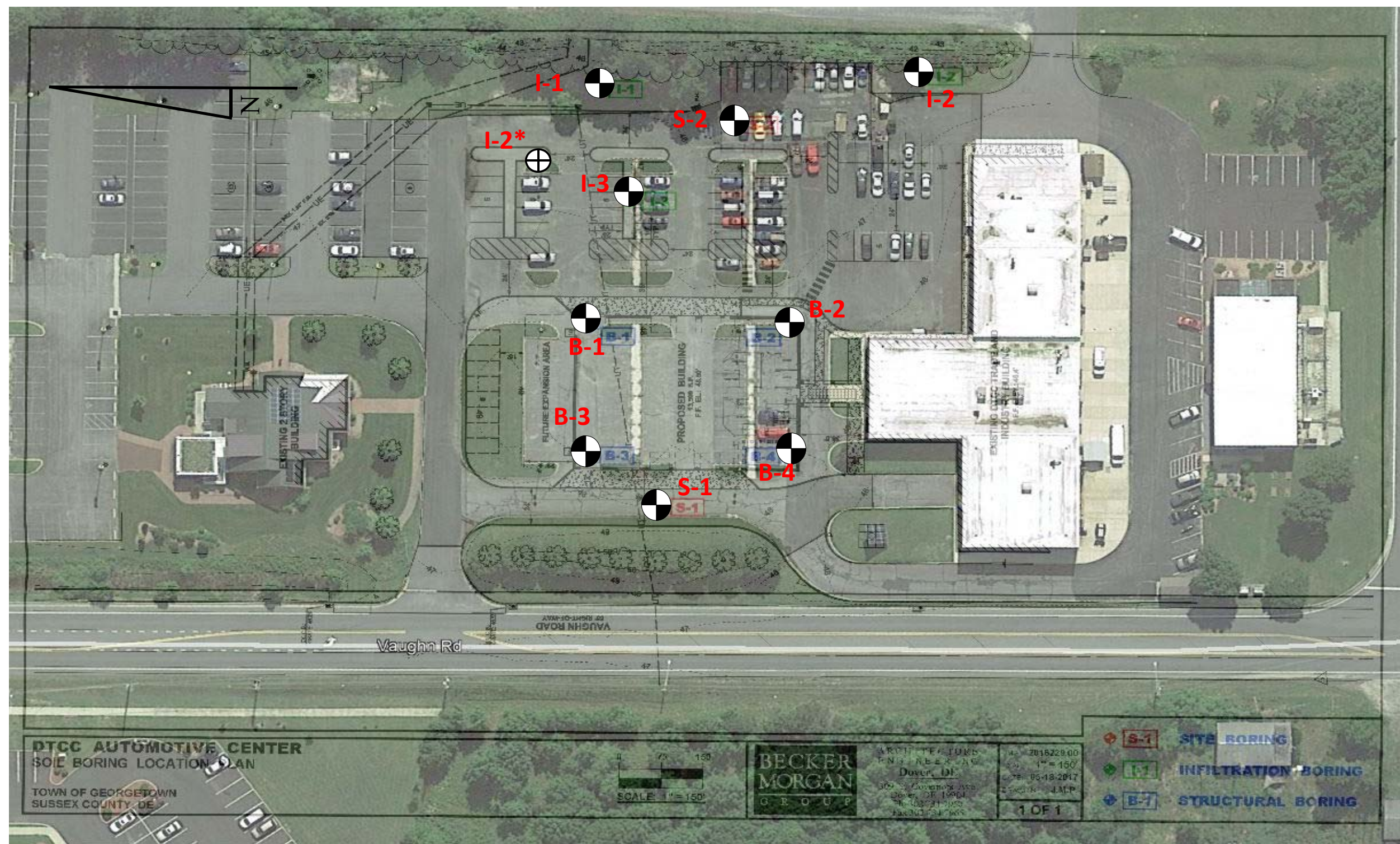
Site Location Plan taken from Google Maps





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 Georgetown, Delaware 19947
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Site Location Plan
DelTech Automotive
Sussex County, Delaware

SCALE	DATE	DRAWN BY	DESIGN BY	REVIEW BY	JOB NO.
NTS	April 2019	GTA	Google Maps	GRS	31190200



Exploration Location Plan taken from a plan titled *DTCC Automotive Center* prepared by Becker Morgan Group, LLC. and dated May 18, 2017.

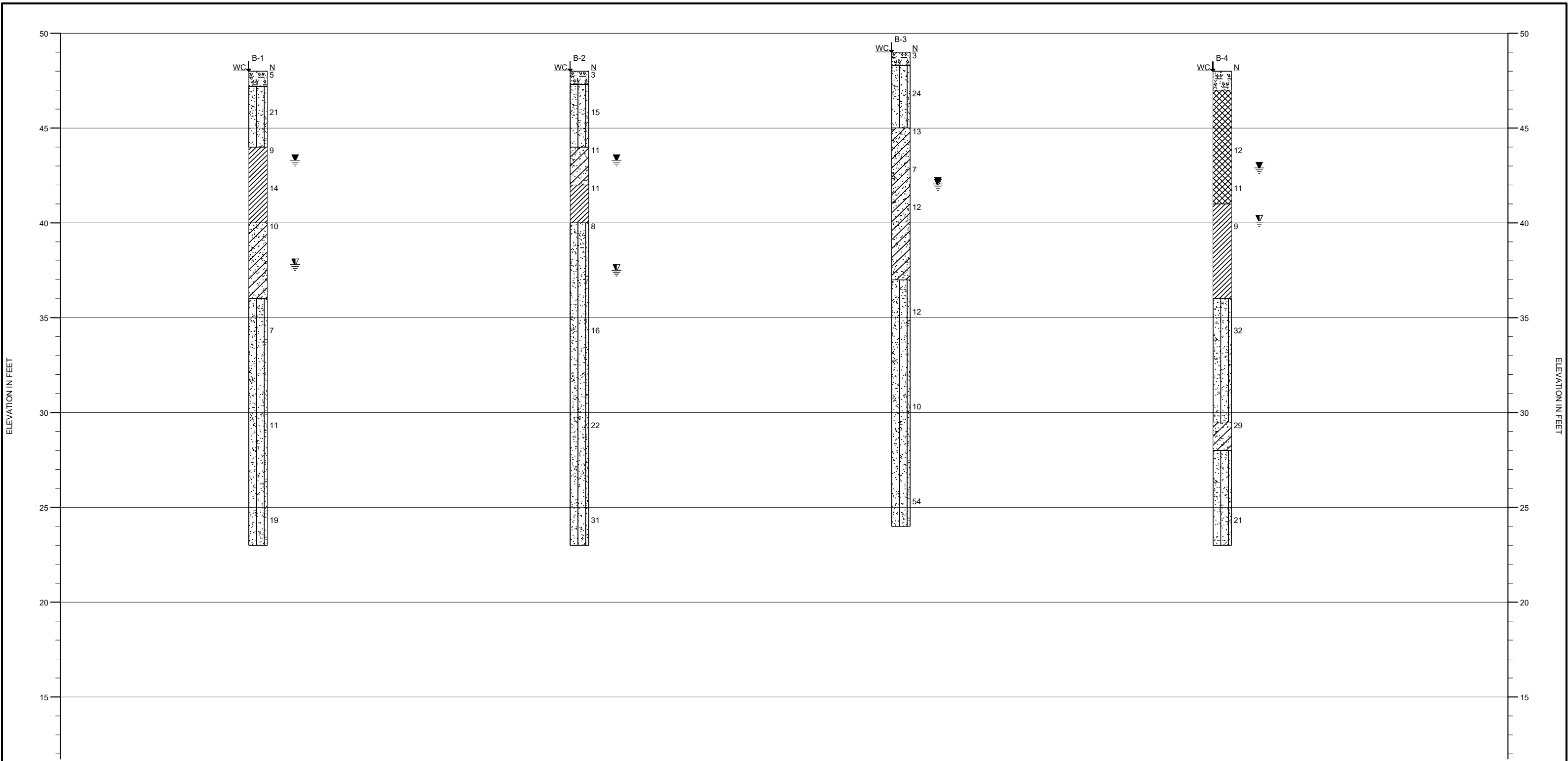
-  Boring Location
-  Infiltration Location



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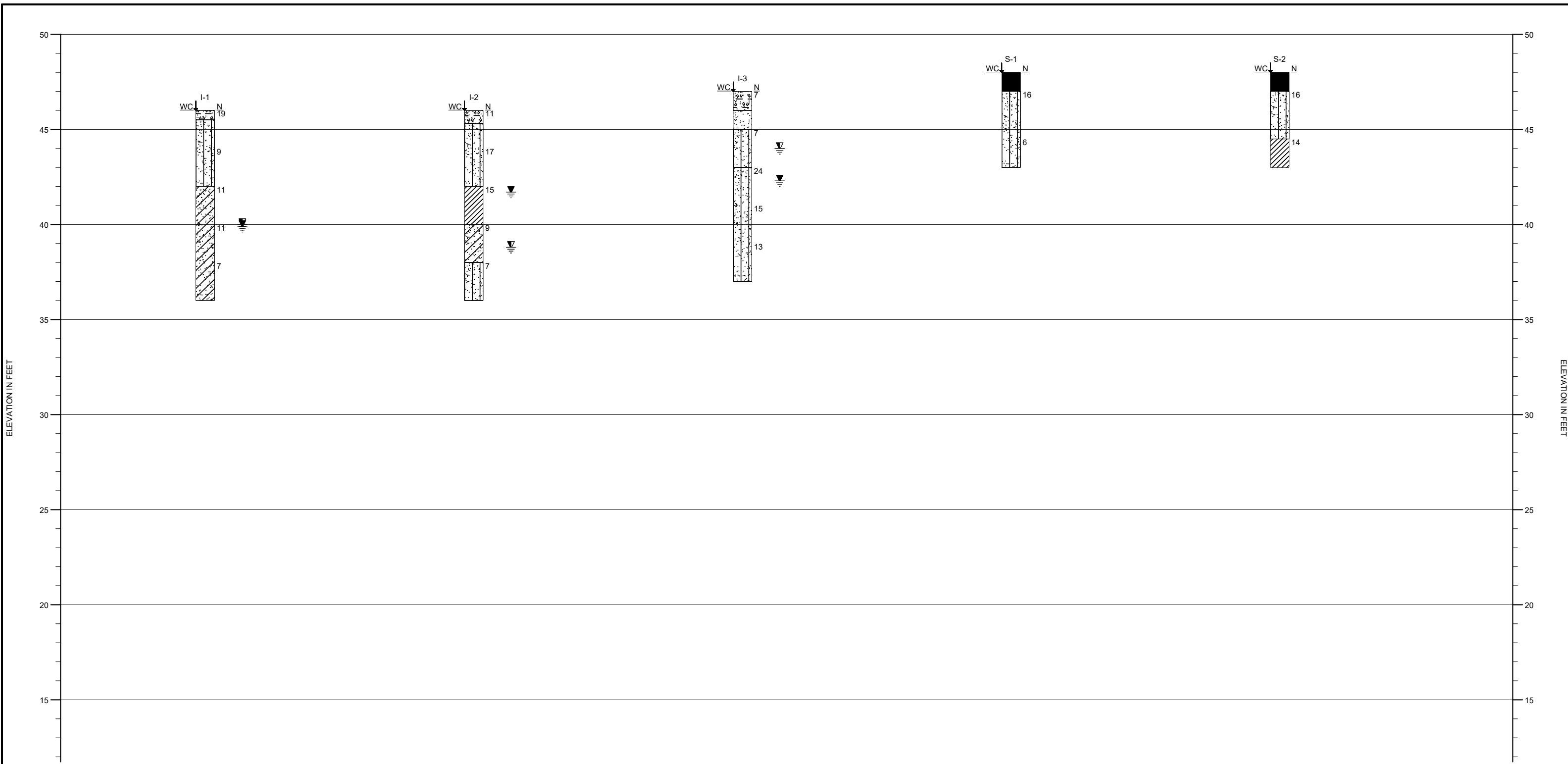
Exploration Location Plan
DelTech Automotive
Sussex County, Delaware

SCALE	DATE	DRAWN BY	DESIGN BY	REVIEW BY	JOB NO.	Figure
1" ~ 75'	April 2019	GTA	BMG	GRS	31190200	2



Symbol Description		
	Topsoil	
	SP-SM - Poorly Graded Sand with Silt	
	CL - Lean Clay	
	SC - Clayey Sand	

Geo-Technology Associates, Inc.			
SUBSURFACE PROFILE			
VERTICAL SCALE: 1"=5'	DRAWN BY TPC	APPROVED BY GRS	DATE: 4/6/ 2019
Deltech Automotive Georgetown, Delaware			
PROJECT NO. 31190200			FIGURE No. 3



Symbol Description

Topsoil	SP - Poorly Graded Sand	Water table during drilling
SP-SM - Poorly Graded Sand with Silt	SM - Silty Sand	Water table at completion
SC - Clayey Sand	Paving	Water table at 3rd check
CL - Lean Clay	Approximate horizontal location of exploration	

Geo-Technology Associates, Inc.			
SUBSURFACE PROFILE			
VERTICAL SCALE: 1"=5'	DRAWN BY TPC	APPROVED BY GRS	DATE: 4/6/ 2019
Deltech Automotive Georgetown, Delaware			
PROJECT NO. 31190200			FIGURE No. 4

APPENDIX B
EXPLORATION DATA

NOTES FOR EXPLORATION LOGS

KEY TO USCS TERMINOLOGY AND GRAPHIC SYMBOLS

MAJOR DIVISIONS (BASED UPON ASTM D 2488)			SYMBOLS	
			GRAPHIC	LETTER
COARSE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 15% PASSING THE NO. 200 SIEVE)		GW
		GRAVELS WITH FINES (MORE THAN 15% PASSING THE NO. 200 SIEVE)		GP
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LESS THAN 15% PASSING THE NO. 200 SIEVE)		GM
				GC
		SANDS WITH FINES (MORE THAN 15% PASSING THE NO. 200 SIEVE)		SW
				SP
FINE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILT OR CLAY (<15% RETAINED ON THE NO. 200 SIEVE) SILT OR CLAY WITH SAND OR GRAVEL (15% TO 30% RETAINED ON THE NO. 200 SIEVE)	SILTS AND LEAN CLAYS LIQUID LIMIT LESS THAN 50		SM
			SC	
			ML	
			CL	
	SANDY OR GRAVELLY SILT OR CLAY (>30% RETAINED ON THE NO. 200 SIEVE)	ELASTIC SILTS AND FAT CLAYS LIQUID LIMIT GREATER THAN 50		OL
				MH
				CH
				OH
HIGHLY ORGANIC SOILS				PT

COARSE-GRAINED SOILS (GRAVEL AND SAND)

DESIGNATION	BLOWS PER FOOT (BPF) "N"
VERY LOOSE	0 - 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 50
VERY DENSE	>50

NOTE: "N" VALUE DETERMINED AS PER ASTM D 1586

FINE-GRAINED SOILS (SILT AND CLAY)

CONSISTENCY	BPF "N"
VERY SOFT	<2
SOFT	2 - 4
MEDIUM STIFF	5 - 8
STIFF	9 - 15
VERY STIFF	16 - 30
HARD	>30

NOTE: ADDITIONAL DESIGNATIONS TO ADVANCE SAMPLER INDICATED IN BLOW COUNT COLUMN:
 WOH = WEIGHT OF HAMMER
 WOR = WEIGHT OF ROD(S)

SAMPLE TYPE

DESIGNATION	SYMBOL
SOIL SAMPLE	S-
SHELBY TUBE	U-
ROCK CORE	R-

NOTE: DUAL SYMBOLS ARE USED TO INDICATE COARSE-GRAINED SOILS WHICH CONTAIN AN ESTIMATED 5 TO 15% FINES BASED ON VISUAL CLASSIFICATION OR BETWEEN 5 AND 12% FINES BASED ON LABORATORY TESTING; AND FINE-GRAINED SOILS WHEN THE PLOT OF LIQUID LIMIT & PLASTICITY INDEX VALUES FALLS IN THE PLASTICITY CHART'S CROSS-HATCHED AREA. FINE-GRAINED SOILS ARE CLASSIFIED AS ORGANIC (OL OR OH) WHEN ENOUGH ORGANIC PARTICLES ARE PRESENT TO INFLUENCE ITS PROPERTIES. LABORATORY TEST RESULTS ARE USED TO SUPPLEMENT SOIL CLASSIFICATION BY THE VISUAL-MANUAL PROCEDURES OF ASTM D 2488.

ADDITIONAL TERMINOLOGY AND GRAPHIC SYMBOLS

ADDITIONAL DESIGNATIONS	DESCRIPTION		GRAPHIC SYMBOLS
	TOPSOIL		
	MAN MADE FILL		
	GLACIAL TILL		
	COBBLES AND BOULDERS		
RESIDUAL SOIL DESIGNATIONS	DESCRIPTION	"N" VALUE	GRAPHIC SYMBOLS
	HIGHLY WEATHERED ROCK	50 TO 50/1"	
	PARTIALLY WEATHERED ROCK	MORE THAN 50 BLOWS FOR 1" OF PENETRATION OR LESS, AUGER PENETRABLE	

WATER DESIGNATION

DESCRIPTION	SYMBOL
ENCOUNTERED DURING DRILLING	
UPON COMPLETION OF DRILLING	
24 HOURS AFTER COMPLETION	

NOTE: WATER OBSERVATIONS WERE MADE AT THE TIME INDICATED. POROSITY OF SOIL STRATA, WEATHER CONDITIONS, SITE TOPOGRAPHY, ETC. MAY CAUSE WATER LEVEL CHANGES.

LOG OF BORING NO. B-1

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ 10.2 ∇ _____ ∇ 4.7
 DATE: 3/14/19 _____ 3/15/19
 CAVED (ft): - _____ -

DATE STARTED: **3/14/19**
 DATE COMPLETED: **3/14/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **10.2**
 GROUND SURFACE ELEVATION: **48**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
									DESCRIPTION		
1	0.0	16	2-2-3-10	5	48.0	0	TS		Topsoil: 10 in		
					47.2		SP-SM		Brown, moist, loose to medium dense, Poorly-graded SAND with Silt		
2	2.0	16	7-9-12-11	21							
3	4.0	18	7-4-5-6	9	44.0	5	CL		Gray, moist, stiff, Lean CLAY		∇
4	6.0	16	4-6-8-8	14							
5	8.0	16	3-4-6-5	10	40.0	10	SC		Gray, moist to wet, loose, Clayey SAND		∇
					36.0						
6	13.5	14	1-5-2	7		15	SP-SM		Tan-orange, wet, loose to medium dense, Poorly-graded SAND with Silt		
7	18.5	13	3-4-7	11		20					
8	23.5	18	11-10-9	19		25					
					23.0	25			Bottom of hole 25 ft		
						30					

NOTES:



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LOG OF BORING NO. B-1

LOG OF BORING NO. B-2

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ **10.5** ∇ _____ ∇ **4.7**
 DATE: **3/14/19** _____ **3/15/19**
 CAVED (ft): **-** _____ **-**

DATE STARTED: **3/14/19**
 DATE COMPLETED: **3/14/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **10.5**
 GROUND SURFACE ELEVATION: **48**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
									DESCRIPTION		
1	0.0	5	1-1-2-8	3	48.0	0	TS		Topsoil: 8 in		
					47.3		SP-SM		Brown, moist, very loose to medium dense, Poorly-graded SAND with Silt		
2	2.0	14	7-7-8-7	15							
3	4.0	18	4-5-6-5	11	44.0	5	SC		Gray, moist, medium dense, Clayey SAND		∇
4	6.0	16	2-5-6-7	11	42.0		CL		Gray, moist, stiff, Lean CLAY		
5	8.0	18	4-3-5-5	8	40.0		SP-SM		Tan-orange, moist to wet, loose to dense, Poorly-graded SAND with Silt		∇
						10					
6	13.5	18	6-9-7	16		15					
7	18.5	13	10-11-11	22		20					
8	23.5	18	9-21-10	31		25					
					23.0	25			Bottom of hole 25 ft		
						30					

NOTES:



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LOG OF BORING NO. B-2

LOG OF BORING NO. B-3

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ **7.0** ∇ _____ ∇ **6.9**
 DATE: **3/15/19** _____ **3/20/19**
 CAVED (ft): **-** _____ **-**

DATE STARTED: **3/15/19**
 DATE COMPLETED: **3/15/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **7.0**
 GROUND SURFACE ELEVATION: **49**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
									DESCRIPTION		
1	0.0		2-2-1-5	3	49.0	0	TS		Topsoil: 8 in		
					48.3		SP-SM		Brown, moist, very loose to medium dense, Poorly-graded SAND with Silt		
2	2.0	10	7-13-11-10	24	45.0	5	SC		Black-brown, moist to wet, loose to medium dense, Clayey SAND		∇
3	4.0	14	5-8-5-5	13							
4	6.0	16	3-3-4-6	7	37.0	10	SP-SM		Brown, wet, loose to very dense, Poorly-graded SAND with Silt		
5	8.0	14	6-6-6-5	12							
6	13.5	14	6-5-7	12	15	20	SP-SM		Brown, wet, loose to very dense, Poorly-graded SAND with Silt		
7	18.5	18	6-6-4	10							
8	23.5	18	44-39-15	54	24.0	25			Bottom of hole 25 ft		
						30					

NOTES:



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 Georgetown, DE 19947

LOG OF BORING NO. B-3

LOG OF BORING NO. B-4

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ **7.9** ∇ _____ ∇ **5.1**
 DATE: **3/15/19** _____ **3/20/19**
 CAVED (ft): **-** _____ **-**

DATE STARTED: **3/15/19**
 DATE COMPLETED: **3/15/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **7.9**
 GROUND SURFACE ELEVATION: **48**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
									DESCRIPTION		
1	0.0				48.0	0	TS		Topsoil: 12 in.		*Auger down to 4' to avoid utility
					47.0		FILL		Dark brown, moist, Silty SAND (FILL)		
2	2.0						FILL		Black, moist to wet, medium dense, Poorly-graded SAND with Silt (FILL)		From 4'-6' Organic Content: 2.9%
3	4.0	16	7-7-5-6	12		5					∇
4	6.0	18	2-6-5-6	11	41.0		CL		Gray, moist to wet, stiff, Lean CLAY		∇
5	8.0	16	6-4-5-7	9		10					
					36.0		SP-SM		Brown-gray, moist, dense, Poorly- graded SAND with Silt		
6	13.5	18	12-15-17	32		15					
					29.5		SC		Brown-gray, wet, medium dense, Clayey SAND		
7	18.5	18	16-16-13	29		20					
					28.0		SP-SM		Brown, wet, medium dense, Poorly-graded SAND with Silt		
9	23.5	18	12-11-10	21		25			Bottom of hole 25 ft		
					23.0						
						30					

NOTES: *Hand Auger down to 4 feet



GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. B-4

LOG OF BORING NO. I-1

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ **6.0** ∇ _____ ∇ **6.1**
 DATE: **3/14/19** _____ **3/15/19**
 CAVED (ft): - _____ -

DATE STARTED: **3/14/19**
 DATE COMPLETED: **3/14/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **6.0**
 GROUND SURFACE ELEVATION: **46**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
1	0.0	12	6-11-8-7	19	46.0	0	TS		Topsoil: 6 in		
					45.5		SP-SM		Brown, moist, loose to medium dense, Poorly-graded SAND with Silt USDA: Loamy Sand to Sand		
2	2.0	13	5-5-4-4	9	42.0	5	SC		Brown, moist to wet, loose to medium dense, Clayey SAND USDA: Sandy Clay Loam		∇
3	4.0	16	3-4-7-7	11							
4	6.0	18	4-4-7-7	11	36.0	10		Bottom of hole 10 ft			
5	8.0	18	2-3-4-4	7							
						15					
						20					
						25					
						30					

NOTES:



GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. I-1

LOG OF BORING NO. I-2

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ 7.2 ∇ _____ ∇ 4.3
 DATE: 3/14/19 _____ 3/15/19
 CAVED (ft): - _____ -

DATE STARTED: **3/14/19**
 DATE COMPLETED: **3/14/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **7.2**
 GROUND SURFACE ELEVATION: **46**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
					46.0	0	TS		Topsoil: 8 in		
1	0.0	14	5-5-6-8	11	45.3		SP-SM		Brown, moist, medium dense, Poorly-graded SAND with Silt USDA: Loamy Sand to Sand		
2	2.0	16	7-8-9-9	17							
3	4.0	16	6-7-8-9	15	42.0	5	CL		Gray-orange, moist, stiff, Lean CLAY USDA: Clay Loam		∇
4	6.0	16	5-4-5-5	9	40.0		SC		Gray, moist to wet, loose, Clayey SAND USDA: Sandy Clay Loam		∇
5	8.0	18	3-4-3-3	7	38.0		SP-SM		Gray, wet, loose, Poorly-graded SAND with Silt USDA: Loamy Sand to Sand		
					36.0	10			Bottom of hole 10 ft		
						15					
						20					
						25					
						30					

NOTES:



GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. I-2

LOG OF BORING NO. I-3

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): ∇ **3.0** ∇ _____ ∇ **4.7**
 DATE: **3/14/19** _____ **3/15/19**
 CAVED (ft): - _____ -

DATE STARTED: **3/14/19**
 DATE COMPLETED: **3/14/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) ∇ **3.0**
 GROUND SURFACE ELEVATION: **47**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
1	0.0	3	4-4-3-3	7	47.0	0	TS		Topsoil: 12 in		
					46.0		SP		Brown, moist, loose, Poorly-graded SAND with Gravel USDA: Loamy Sand to Sand		
2	2.0	5	2-3-4-7	7	45.0		SP-SM		Brown, moist to wet, loose, Poorly-graded SAND with Silt USDA: Loamy Sand to Sand		∇
					43.0		SM		Gray, wet, medium dense, Silty SAND USDA: Sandy Loam		
3	4.0	14	7-11-13-13	24		5					∇
4	6.0	16	5-7-8-8	15							
5	8.0	14	5-6-7-7	13							
					37.0	10			Bottom of hole 10 ft		
						15					
						20					
						25					
						30					

NOTES:



GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. I-3

LOG OF BORING NO. S-1

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): **Dry 5**
 DATE: **3/15/19**
 CAVED (ft): **-**

DATE STARTED: **3/15/19**
 DATE COMPLETED: **3/15/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) **NE**
 GROUND SURFACE ELEVATION: **48**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
					48.0	0			Asphalt: 4"		
					47.0				Stone subbase: 8"		
1	1.0	6	6-9-7-8	16			SP-SM		Black, moist, medium dense, Poorly-graded SAND with Silt		
2	3.5	14	4-3-3	6							Hole backfilled and patched at completion
					43.0	5			Bottom of hole 5 ft.		
						10					
						15					
						20					
						25					
						30					

NOTES: **NE: Not Encountered**
Boring backfilled at completion



GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. S-2

PROJECT: **Deltech Automotive**
 PROJECT NO.: **31190200**
 PROJECT LOCATION: **Georgetown, Delaware**

WATER LEVEL (ft): **Dry 5**
 DATE: **3/15/19**
 CAVED (ft): **-**

DATE STARTED: **3/15/19**
 DATE COMPLETED: **3/15/19**
 DRILLING CONTRACTOR: **Manos Drilling Associates**
 DRILLER: **K. Manos**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Splitspoon**

WATER ENCOUNTERED DURING DRILLING (ft) **NE**
 GROUND SURFACE ELEVATION: **48**
 DATUM: **Topo**
 EQUIPMENT: **CME 55**
 LOGGED BY: **TPC**
 CHECKED BY: **GRS**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
									DESCRIPTION		
					48.0	0			Asphalt: 4"		
					47.0				Stone subbase: 8"		
1	1.0	6	6-9-7-8	16			SP-SM		Black, moist, medium dense, Poorly-graded SAND with Silt		
					44.5				Gray, moist, stiff, Lean CLAY		
2	3.5	14	5-6-8	14			CL				
					43.0	5			Bottom of hole 5 ft.		Hole backfilled and patched at completion
						10					
						15					
						20					
						25					
						30					

NOTES: **NE: Not Encountered**
Boring backfilled at completion



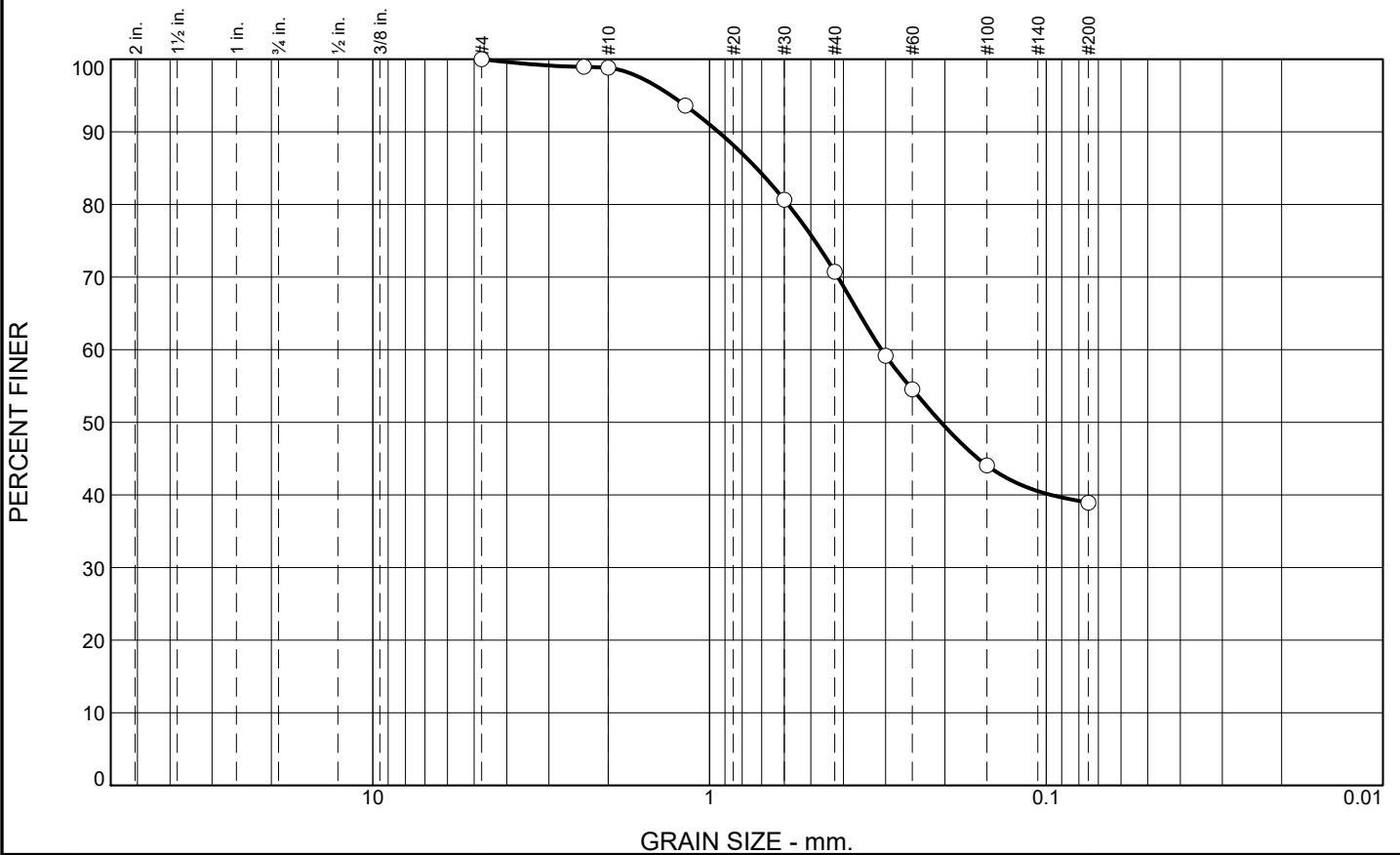
GEO-TECHNOLOGY ASSOCIATES, INC.

21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

LOG OF BORING NO. S-2

APPENDIX C
LABORATORY DATA

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	1.1	28.2	31.8	38.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
# 4	100.0		
# 8	99.0		
# 10	98.9		
# 16	93.6		
# 30	80.6		
# 40	70.7		
# 50	59.2		
# 60	54.5		
# 100	44.1		
# 200	38.9		

Soil Description

Brown, Silty SAND

Atterberg Limits

PL= NP LL= NP PI= NP NM= 14.1

Coefficients

D₉₀= 0.9412 D₈₅= 0.7252 D₆₀= 0.3086
D₅₀= 0.2052 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification


USCS= SM AASHTO= A-4(0)

Remarks

* (no specification provided)

Location: B-4
Depth: 1-4'

Date: 3/18/19

	GEO-TECHNOLOGY ASSOCIATES, INC. 21133 Sterling Avenue, Suite 7 Georgetown, DE 19947	Client: Becker Morgan Group Project: Deltech Automotive Project No: 31190200	Figure
---	--	---	---------------

Tested By: SW **Checked By:** GRS

MOISTURE-DENSITY RELATIONSHIP TEST REPORT

ASTM D 1557-12 Method A Modified

Project No.: 31190200

Date: 3/18/2019

Project: Deltech Automotive

Client: Becker Morgan Group

Location: B-4

Depth: 1-4'

Remarks:

MATERIAL DESCRIPTION

Description: Brown, Silty SAND

Classifications -

USCS: SM

AASHTO: A-4(0)

Nat. Moist. = 14.1 %

Sp.G. =

Liquid Limit = NP

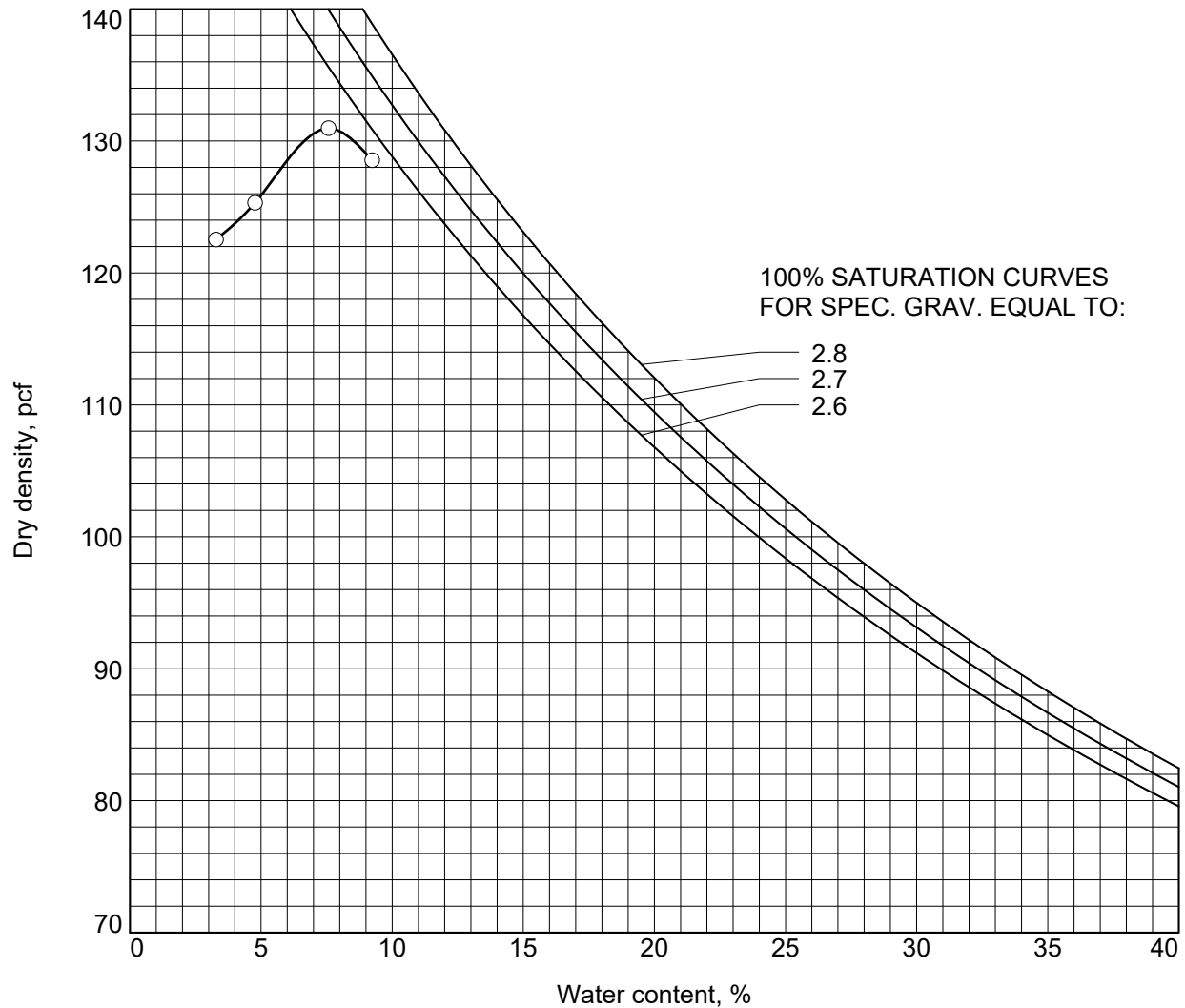
Plasticity Index = NP

% < No.200 = 38.9 %

TEST RESULTS

Maximum dry density = 131.0 pcf

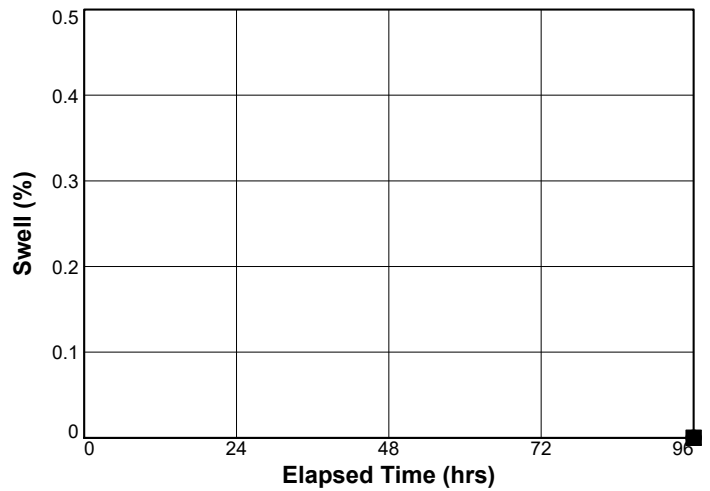
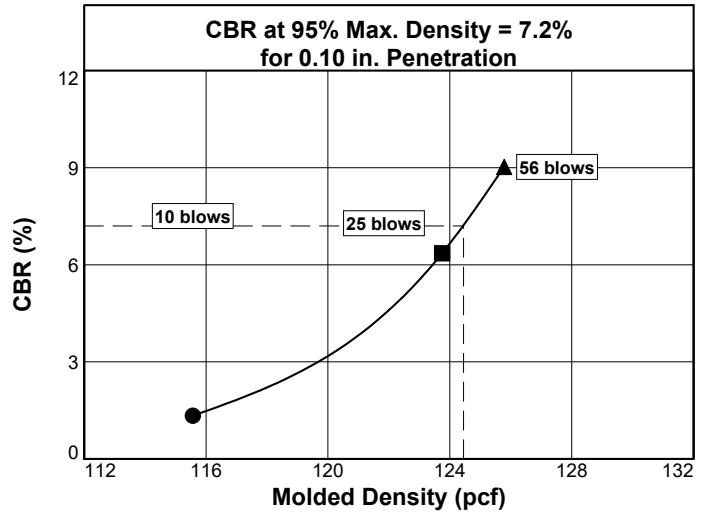
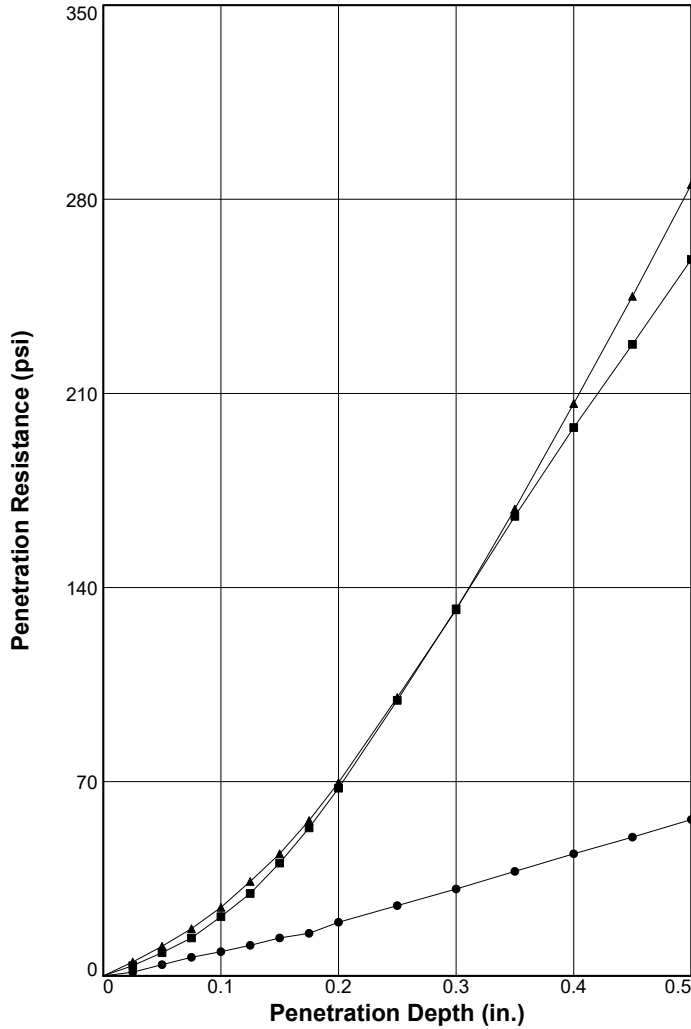
Optimum moisture = 7.6 %



Figure

BEARING RATIO TEST REPORT

ASTM D1883-14



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	115.6	88.2	10.6	115.6	88.2	11.9	1.3	1.7	0.047	10	0
2 ▲	125.8	96	9.6	125.8	96	14.0	9.0	10.4	0.134	10	0
3 ■	123.7	94.4	11.7	123.7	94.5	14.2	6.4	8.5	0.093	10	0
Material Description							USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Brown, Silty SAND											

Project No: 31190200
Project: Deltech Automotive
Location: B-4
Depth: 1-4'
Date: 3/18/19

Test Description/Remarks:



GEO-TECHNOLOGY ASSOCIATES, INC.
 21133 Sterling Avenue, Suite 7
 Georgetown, DE 19947

Figure _____

SUBCONTRACTOR LISTING

If awarded this contract, we _____ (name of Bidder) intend to award subcontracts to the following subcontractors. Where we intend to perform the work with our own forces, our name is listed as subcontractor. This form is to be submitted with the Bid. A brief description is given below for each subcontractor/trade-(scope of work). Refer to the individual specification sections for full description.

Demolition & Clearing Name: _____

Address: _____

Site Work- Underground Utilities Name: _____

Address: _____

Site Work – Grading and Earthwork Name: _____

Address: _____

Concrete Name: _____

Address: _____

Masonry Name: _____

Address: _____

Doors and Glazing Name: _____

Address: _____

Overhead Doors Name: _____

Address: _____

Drywall and Metal Stud Name: _____

Address: _____

Floor Coverings Name: _____

Address: _____

Traffic Coating Name: _____

Address: _____

Painting

Name: _____

Address: _____

Mechanical

Name: _____

Address: _____

Sprinkler

Name: _____

Address: _____

Electrical

Name: _____

Address: _____

Metal Building System

Name: _____

Address: _____

Date

Firm Name

Signature

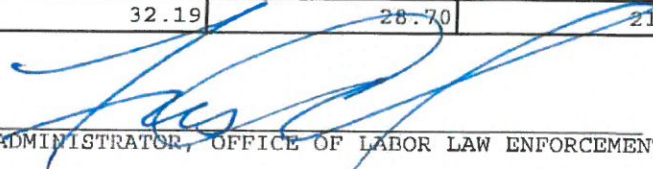
STATE OF DELAWARE
DEPARTMENT OF LABOR
DIVISION OF INDUSTRIAL AFFAIRS
OFFICE OF LABOR LAW ENFORCEMENT
PHONE: (302) 761-8200

Mailing Address:
4425 North Market Street
3rd Floor
Wilmington, DE 19802

Located at:
4425 North Market Street
3rd Floor
Wilmington, DE 19802

PREVAILING WAGES FOR BUILDING CONSTRUCTION EFFECTIVE MARCH 15, 2019

CLASSIFICATION	NEW CASTLE	KENT	SUSSEX
ASBESTOS WORKERS	23.92	29.46	42.87
BOILERMAKERS	71.61	36.33	53.41
BRICKLAYERS	55.89	55.89	55.89
CARPENTERS	55.63	55.63	44.22
CEMENT FINISHERS	75.54	52.62	23.19
ELECTRICAL LINE WORKERS	47.57	40.79	31.10
ELECTRICIANS	70.49	70.49	70.49
ELEVATOR CONSTRUCTORS	96.27	67.47	33.42
GLAZIERS	75.65	75.65	59.28
INSULATORS	57.88	57.88	57.88
IRON WORKERS	65.57	65.57	65.57
LABORERS	47.70	47.70	47.70
MILLWRIGHTS	74.23	74.23	59.84
PAINTERS	52.47	52.47	52.47
PILEDRIVERS	78.02	41.17	33.30
PLASTERERS	31.22	31.22	23.14
PLUMBERS/PIPEFITTERS/STEAMFITTERS	70.05	55.29	60.31
POWER EQUIPMENT OPERATORS	71.29	71.29	71.29
ROOFERS-COMPOSITION	25.12	24.79	22.64
ROOFERS-SHINGLE/SLATE/TILE	19.24	22.88	17.99
SHEET METAL WORKERS	72.53	72.53	72.53
SOFT FLOOR LAYERS	53.39	53.39	53.39
SPRINKLER FITTERS	60.04	60.04	60.04
TERRAZZO/MARBLE/TILE FNRS	64.45	64.45	64.45
TERRAZZO/MARBLE/TILE STRS	71.27	71.27	71.27
TRUCK DRIVERS	32.19	28.70	21.91

CERTIFIED: 06/25/2019 BY: 
ADMINISTRATOR, OFFICE OF LABOR LAW ENFORCEMENT

NOTE: THESE RATES ARE PROMULGATED AND ENFORCED PURSUANT TO THE PREVAILING WAGE REGULATIONS ADOPTED BY THE DEPARTMENT OF LABOR ON APRIL 3, 1992.

CLASSIFICATIONS OF WORKERS ARE DETERMINED BY THE DEPARTMENT OF LABOR. FOR ASSISTANCE IN CLASSIFYING WORKERS, OR FOR A COPY OF THE REGULATIONS OR CLASSIFICATIONS, PHONE 302-761-8200

NON-REGISTERED APPRENTICES MUST BE PAID THE MECHANIC'S RATE.

PROJECT: DTCC Automotive Center of Excellence , Sussex County

General Decision Number: DE190009 04/19/2019 DE9

Superseded General Decision Number: DE20180015

State: Delaware

Construction Type: Building

County: Sussex County in Delaware.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.60 for calendar year 2019 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.60 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2019. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/04/2019
1	04/19/2019

BOIL0013-009 01/01/2016

	Rates	Fringes
BOILERMAKER.....	\$ 42.26	37.02

BRDE0001-001 05/01/2018

	Rates	Fringes
BRICKLAYER		
Brick Refractory/Brick Placement Worker.....	\$ 32.47	23.37
Bricklayer.....	\$ 32.47	23.37

CARP0173-011 05/01/2017

	Rates	Fringes
CARPENTER (Includes Acoustical Ceiling Installation, Drywall Hanging, Form Work, Metal Stud Installation, Scaffold Building, Excludes Masonry/Brick, and Excludes Soft Floor Layer).....	\$ 24.98	17.84

 CARP0251-008 05/01/2016

	Rates	Fringes
SOFT FLOOR LAYER.....	\$ 29.96	21.04

 CARP1906-003 07/01/2015

	Rates	Fringes
MILLWRIGHT.....	\$ 36.05	30.63

 ELEC0313-002 06/01/2018

	Rates	Fringes
ELECTRICIAN (Includes Low Voltage Wiring and Installation of Alarms, HVAC/Temperature Controls and Sound and Communication Systems).....	\$ 39.60	30.46

 ELEV0005-003 01/01/2018

	Rates	Fringes
ELEVATOR MECHANIC.....	\$ 55.76	32.645+A&B

FOOTNOTES FOR ELEVATOR MECHANICS:

- A. PAID VACATION: Employer contributes 8% of basic hourly rate for 5 years or more of service or 6% for 6 months to 5 years of service.
- B. Eight Paid Holidays (provided employee has worked 5 consecutive days before and the working day after the holiday): New Years's Day; Memorial Day; Independence Day; Labor Day; Veteran's Day; Thanksgiving Day and the Friday after Thanksgiving Day, and Christmas Day.

 ENGI0542-003 05/01/2018

	Rates	Fringes
POWER EQUIPMENT OPERATOR (Forklift).....	\$ 39.85	27.11+A

FOOTNOTE: A. PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas Day, and Election Day (provided the employee works the scheduled work day following the holiday.)

IRON0451-003 07/01/2018

	Rates	Fringes
IRONWORKER (Ornamental and Reinforcing).....	\$ 35.10	30.35

The following holidays shall be observed, and when work is performed thereon it shall be paid for at twice the base wage rate: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

LABO0199-006 05/01/2016

	Rates	Fringes
LABORER Backfiller, Jack Hammer, Mason Tender - Brick, Pipelayer, Scaffold Builder (Brick and Masonry), Tamper (Hand Held).....	\$ 24.55	19.30
Mason Tender - Cement/Concrete.....	\$ 24.80	19.30

PAIN0252-002 05/01/2017

	Rates	Fringes
GLAZIER.....	\$ 41.30	28.06

PLAS0008-006 05/01/2017

	Rates	Fringes
PLASTERER (Fireproofers).....	\$ 37.42	28.83

PLAS0592-009 05/01/2018

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER....	\$ 31.79	25.58

PLUM0074-003 06/13/2016

	Rates	Fringes
PIPEFITTER (INDUSTRIAL).....	\$ 48.83	33.30

FOOTNOTE A: PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, Labor Day, Christmas

Day, and General Election Day.

 * PLUM0486-001 12/16/2018

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation and Excludes Industrial Work).....	\$ 40.10	19.89

 SFDE0669-002 04/01/2018

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	\$ 36.55	22.69

 SHEE0019-021 07/01/2018

	Rates	Fringes
SHEET METAL WORKER (Includes HVAC Duct Installation).....	\$ 32.37	39.06

 SUDE2014-006 01/20/2016

	Rates	Fringes
IRONWORKER, STRUCTURAL.....	\$ 43.59	7.41
LABORER: Common or General.....	\$ 24.45	8.65
OPERATOR: Backhoe/Excavator/Trackhoe.....	\$ 36.08	12.02
OPERATOR: Bulldozer.....	\$ 25.89	0.00
OPERATOR: Crane.....	\$ 31.59	16.83
PAINTER (Brush and Roller).....	\$ 40.57	0.94
PLUMBER.....	\$ 45.40	16.23
ROOFER (Installation of Metal Roofs Only).....	\$ 39.09	30.77
ROOFER, Excludes Installation of Metal Roofs.....	\$ 27.98	27.90
TILE FINISHER.....	\$ 35.40	4.31
TILE SETTER.....	\$ 57.98	1.11

 WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.
 =====

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and

the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

General Decision Number: DE190004 01/04/2019 DE4

Superseded General Decision Number: DE20180004

State: Delaware

Construction Type: Highway

County: Sussex County in Delaware.

HIGHWAY CONSTRUCTION PROJECTS

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.60 for calendar year 2019 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.60 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2019. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/04/2019

SUDE2018-001 03/15/2018

	Rates	Fringes
BRICKLAYER.....	\$ 53.89	
CARPENTER.....	\$ 43.57	
CEMENT MASON/CONCRETE FINISHER....	\$ 27.71	
ELECTRICIAN		
Electrician.....	\$ 68.70	
Line Workers.....	\$ 22.69	
IRONWORKER.....	\$ 27.06	

LABORER.....\$ 39.95
 MILLWRIGHT.....\$ 14.41
 PAINTER.....\$ 68.79
 POWER EQUIPMENT OPERATOR
 Piledriver.....\$ 28.77
 Power Equipment Operators...\$ 38.73
 SHEET METAL WORKER.....\$ 19.64
 TRUCK DRIVER.....\$ 36.72

 WELDERS - Receive rate prescribed for craft performing
 operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or

"UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

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A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can

be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

CERTIFICATION REGARDING LOBBYING LOWER TIER COVERED TRANSACTIONS

Applicants should review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, "New Restrictions on Lobbying."

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over \$100,000 or a loan or loan guarantee over \$150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure occurring on or before October 23, 1996, and of not less than \$11,000 and not more than \$110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure occurring on or before October 23, 1996, and of not less than \$11,000 and not more than \$110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

NAME OF APPLICANT

AWARD NUMBER AND/OR PROJECT NAME

PRINTED NAME AND TITLE OF AUTHORIZED REPRESENTATIVE

SIGNATURE

DATE

**NOTICE OF REQUIREMENTS FOR AFFIRMATIVE ACTION
TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY
(EXECUTIVE ORDER 11246 AND 41 CFR PART 60-4)**

The following Notice shall be included in, and shall be a part of all solicitations for offers and bids on all Federal and federally assisted construction contracts or subcontracts in excess of \$10,000.

The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables	Goals for minority participation for each trade	Goals for female participation for each trade
	%	6.9%

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and non federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order, and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is:

State of _____

County of _____

City of _____

EDA PROJECT SIGN

The Contractor shall supply, erect, and maintain in good condition a project sign according to the specifications set forth below:

EDA SITE SIGN SPECIFICATIONS

Size: 4' x 8' x ¾"

Materials: Exterior grade/MDO plywood (APA rating A-B)

Supports: 4" x 4" x 12' posts with 2" x 4" cross branching

Erection: Posts shall be set a minimum of three feet deep in concrete footings that are at least 12" in diameter.

Paint: Outdoor enamel

Colors: Jet Black, Blue (PMS300), and Gold (PMS7406). Specifically, on white background the following will be placed:

The U. S. Department of Commerce seal in blue, black, and gold;

“EDA” in blue;

“U. S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT
ADMINISTRATION” in black;

“In partnership with” in blue;

(Actual name of the) “EDA Grant Recipient” in black;

Lettering: Specific fonts are named below; positioning will be as shown on the attached illustration.

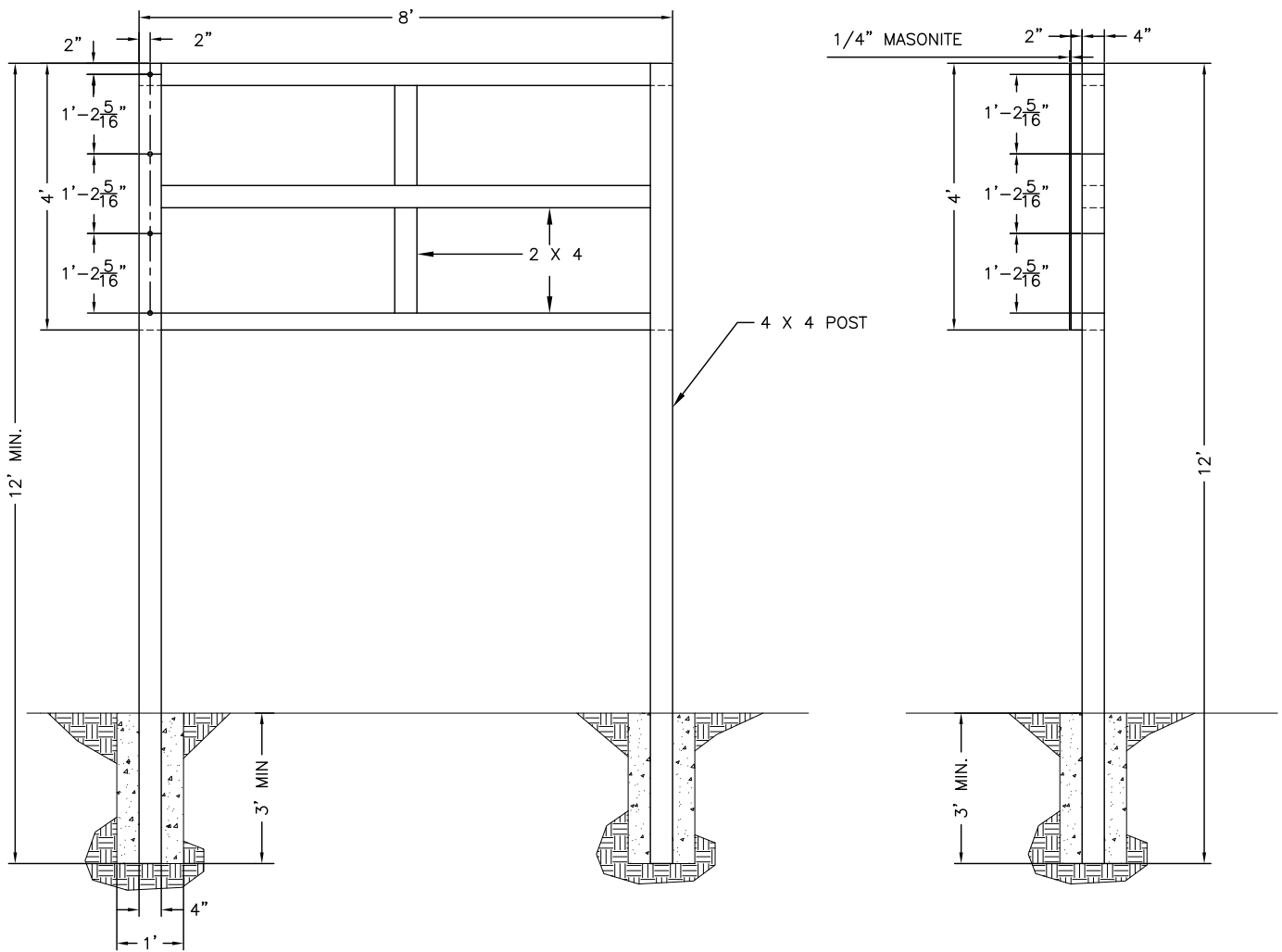
“U. S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT
ADMINISTRATION” use Bank Gothic Medium - **BANK GOTHIC MED**

“In partnership with” use Univers™ 55 Oblique - *Univers 55*

(Name of) “EDA Grant Recipient” use Univers™ Extra Black 85 **Univers 85**

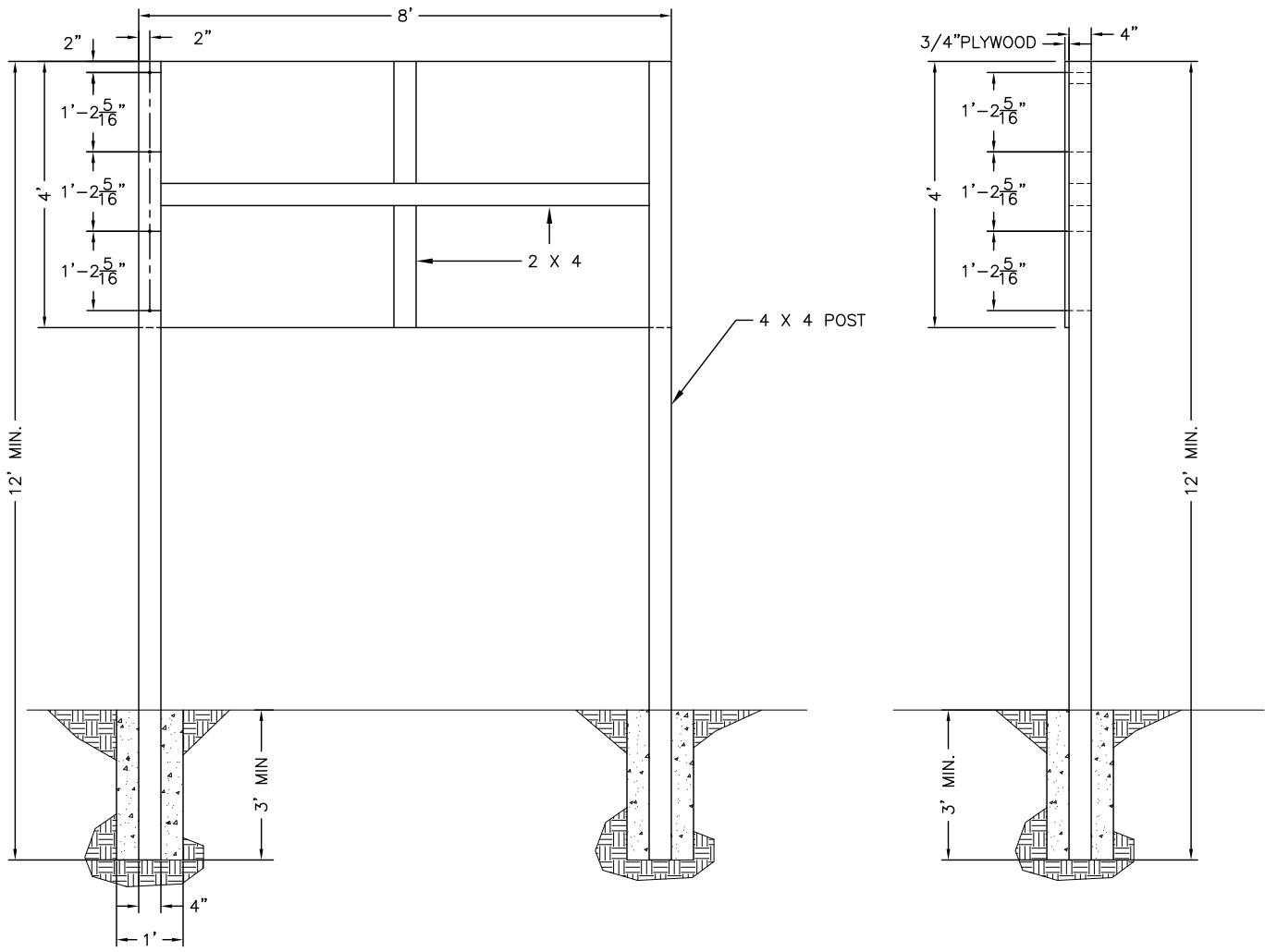
Project signs will not be erected on public highway rights-of-way. If any possibility exists for obstruction to traffic line of sight, the location and height of the sign will be coordinated with the agency responsible for highway or street safety in the area.

The EDA Regional Director may permit modifications to these specifications if they conflict with state law or local ordinances.



SIGN A
 MASONITE SIGN
 SCALE: 3/8" = 1'

PROJECT - SIGN A
ECONOMIC DEVELOPMENT ADMINISTRATION



SIGN B
 PLYWOOD SIGN
 SCALE: 3/8" = 1'

PROJECT - SIGN B
ECONOMIC DEVELOPMENT ADMINISTRATION



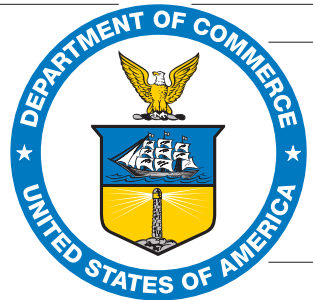
EDA

U.S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT ADMINISTRATION

In partnership with

<EDA Grant Recipient Name>

Black
Blue= PMS300
Gold= PMS7406



EDA

U.S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT ADMINISTRATION

In partnership with

<EDA Grant Recipient Name>

2.25"

13.5"

1.75"

1.75"

10"

2.0"

1.5"

4.0"

3.0"

3.0"

3.75"

15.0"

48"

**U. S. DEPARTMENT OF COMMERCE
ECONOMIC DEVELOPMENT ADMINISTRATION**



**EDA CONTRACTING PROVISIONS
FOR CONSTRUCTION PROJECTS**

These EDA Contracting Provisions for Construction Projects (EDA Contracting Provisions) are intended for use by recipients receiving federal assistance from the U. S. Department of Commerce - Economic Development Administration (EDA). They contain provisions specific to EDA and other federal provisions not normally found in non-federal contract documents. The requirements contained herein must be incorporated into all construction contracts and subcontracts funded wholly or in part with federal assistance from EDA.

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1. **DEFINITIONS**

Agreement – The written instrument that is evidence of the agreement between the Owner and the Contractor overseeing the Work.

Architect/Engineer - The person or other entity engaged by the Recipient to perform architectural, engineering, design, and other services related to the work as provided for in the contract.

Contract – The entire and integrated written agreement between the Owner and the Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

Contract Documents – Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents.

Contractor – The individual or entity with whom the Owner has entered into the Agreement.

Drawings or Plans – That part of the Contract Documents prepared or approved by the Architect/Engineer that graphically shows the scope, extent, and character of the Work to be performed by the Contractor.

EDA - The United States of America acting through the Economic Development Administration of the U.S. Department of Commerce or any other person designated to act on its behalf. EDA has agreed to provide financial assistance to the Owner, which includes assistance in financing the Work to be performed under this Contract. Notwithstanding EDA's role, nothing in this Contract shall be construed to create any contractual relationship between the Contractor and EDA.

Owner – The individual or entity with whom the Contractor has entered into the Agreement and for whom the Work is to be performed.

Project – The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

Recipient – A non-Federal entity receiving a Federal financial assistance award directly from EDA to carry out an activity under an EDA program, including any EDA-approved successor to the entity.

Specifications – That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

Subcontractor – An individual or entity having direct contract with the Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

Work – The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

2. **APPLICABILITY**

The Project to which the construction work covered by this Contract pertains is being assisted by the United States of America through federal assistance provided by the U.S. Department of Commerce - Economic Development Administration (EDA). Neither EDA, nor any of its departments, entities, or employees is a party to this Contract. The following EDA Contracting Provisions are included in this Contract and all subcontracts or related instruments pursuant to the provisions applicable to such federal assistance from EDA.

3. **FEDERALLY REQUIRED CONTRACT PROVISIONS**

(a) All contracts in excess of the simplified acquisition threshold - currently fixed at \$150,000 (*see* 41 U.S.C. §§ 134 and 1908) must address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as may be appropriate.

(b) All contracts in excess of \$10,000 must address termination for cause and for convenience by the Recipient including the manner by which it will be effected and the basis for settlement.

(c) All construction contracts awarded in excess of \$10,000 by recipients of federal assistance and their contractors or subcontractors shall contain a provision requiring compliance with Executive Order 11246 of September 24, 1965, *Equal Employment Opportunity*, as amended by Executive Order 11375 of October 13, 1967, and Department of Labor implementing regulations at 41 C.F.R. part 60.

(d) All prime construction contracts in excess of \$2,000 awarded by Recipients must include a provision for compliance with the Davis-Bacon Act (40 U.S.C. §§ 3141-3148) as supplemented by Department of Labor regulations at 29 C.F.R. part 5. The contracts must also include a provision for compliance with the Copeland "Anti-Kickback" Act (18 U.S.C. § 874 and 40 U.S.C. § 3145) as supplemented by Department of Labor regulations at 29 C.F.R. part 3.

(e) All contracts awarded by the Recipient in excess of \$100,000 that involve the employment of mechanics or laborers must include a provision for compliance with 40 U.S.C. §§ 3702 and 3704 (the Contract Work Hours and Safety Standards Act) as supplemented by Department of Labor regulations at 29 C.F.R. part 5.

(f) All contracts must include EDA requirements and regulations that involve a requirement on the contractor or sub-contractor to report information to EDA, the Recipient or any other federal agency.

- (g) All contracts must include EDA requirements and regulations pertaining to patent rights with respect to any discovery or invention which arises or is developed in the course of or under such contract.
- (h) All contracts must include EDA requirements and regulations pertaining to copyrights and rights in data.
- (i) All contracts and subgrants in excess of \$150,000 must contain a provision that requires compliance with all applicable standards, orders, or requirements issued under the Clean Air Act (42 U.S.C. § 7401 *et seq.*) and the Federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. § 1251 *et seq.*), and Executive Order 11738, *Providing for Administration of the Clean Air Act and the Federal Water Pollution Control Act With Respect to Federal Contracts, Grants, or Loans*.
- (j) Contracts must contain mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C. § 6201).
- (k) Contracts must contain a provision ensuring that contracts are not to be made to parties on the government wide Excluded Parties List System in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 C.F.R. part 180.
- (l) Contracts must contain a provision ensure compliance with the Byrd Anti-Lobbying Amendment (31 U.S.C. § 1352) under which contractors that apply or bid for an award of \$100,000 or more must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. § 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award.
- (m) If the Recipient is a state agency or agency of a political subdivision of a state, any contract awarded must contain a provision ensuring compliance with section 6002 of the Solid Waste Disposal Act (42 U.S.C. § 6962), as amended by the Resource Conservation and Recovery Act related to the procurement of recovered materials.

4. **REQUIRED PROVISIONS DEEMED INSERTED**

Each and every provision of law and clause required by law to be inserted in this contract shall be deemed to be inserted herein and the contract shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party the contract shall forthwith be physically amended to make such insertion of correction.

5. **INSPECTION BY EDA REPRESENTATIVES**

The authorized representatives and agents of EDA shall be permitted to inspect all work, materials, payrolls, personnel records, invoices of materials, and other relevant data and records.

6. **EXAMINATION AND RETENTION OF CONTRACTOR'S RECORDS**

(a) The Owner, EDA, or the Comptroller General of the United States, or any of their duly authorized representatives shall, generally until three years after final payment under this contract, have access to and the right to examine any of the Contractor's directly pertinent books, documents, papers, or other records involving transactions related to this contract for the purpose of making audit, examination, excerpts, and transcriptions.

(b) The Contractor agrees to include in first-tier subcontracts under this contract a clause substantially the same as paragraph (a) above. "Subcontract," as used in this clause, excludes purchase orders that do not exceed \$10,000.

(c) The periods of access and examination in paragraphs (a) and (b) above for records relating to (1) appeals under the disputes clause of this contract, (2) litigation or settlement of claims arising from the performance of this contract, or (3) costs and expenses of this contract to which the Owner, EDA, or Comptroller General or any of their duly authorized representatives has taken exception shall continue until disposition of such appeals, litigation, claims, or exceptions.

7. **CONSTRUCTION SCHEDULE AND PERIODIC ESTIMATES**

Immediately after execution and delivery of the contract, and before the first partial payment is made, the Contractor shall deliver to the Owner an estimated construction progress schedule in a form satisfactory to the Owner, showing the proposed dates of commencement and completion of each of the various subdivisions of work required under the Contract Documents and the anticipated amount of each monthly payment that will become due to the Contractor in accordance with the progress schedule. The Contractor also shall furnish the Owner (a) a detailed estimate giving a complete breakdown of the contract price and (b) periodic itemized estimates of work done for the purpose of making partial payments thereon. The costs employed in making up any of these schedules will be used only to determine the basis of partial payments and will not be considered as fixing a basis for additions to or deductions from the contract price.

8. **CONTRACTOR'S TITLE TO MATERIAL**

No materials, supplies, or equipment for the work shall be purchased by the Contractor or by any subcontractor that is subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller. The Contractor warrants and guarantees that he/she has good title to all work, materials, and equipment used by him/her in the Work, free and clear of all liens, claims, or encumbrances.

9. **INSPECTION AND TESTING OF MATERIALS**

All materials and equipment used in the completion of the Work shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the Owner. Materials of construction, particularly those upon which the strength and durability of any structure may depend, shall be subject to inspection and testing to establish conformance with specifications and suitability for intended uses.

10. **"OR EQUAL" CLAUSE**

Whenever a material, article, or piece of equipment is identified in the Contract Documents by reference to manufacturers' or vendors' names, trade names, catalogue numbers, etc., it is intended merely to establish a standard. Any material, article, or equipment of other manufacturers and vendors that will perform adequately the duties imposed by the general design will be considered equally acceptable provided the material, article, or equipment so proposed is, in the opinion of the Architect/Engineer, of equal substance and function. However, such substitution material, article, or equipment shall not be purchased or installed by the Contractor without the Architect/Engineer's written approval.

11. **PATENT FEES AND ROYALTIES**

(a) Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device that is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Architect/Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by the Owner in the Contract Documents.

(b) To the fullest extent permitted by Laws and Regulations, the Contractor shall indemnify and hold harmless the Owner and the Architect/Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

12. **CLAIMS FOR EXTRA COSTS**

No claims for extra work or cost shall be allowed unless the same was done in pursuance of a written order from the Architect/Engineer approved by the Owner.

13. CONTRACTORS AND SUBCONTRACTORS INSURANCE

(a) The Contractor shall not commence work under this Contract until the Contractor has obtained all insurance reasonably required by the Owner, nor shall the Contractor allow any subcontractor to commence work on his/her subcontract until the insurance required of the subcontractor has been so obtained and approved.

(b) Types of insurance normally required are:

- (1) Workmen's Compensation
- (2) Contractor's Public Liability and Property Damage
- (3) Contractor's Vehicle Liability
- (4) Subcontractors' Public Liability, Property Damage and Vehicle Liability
- (5) Builder's Risk (Fire and Extended Coverage)

(c) **Scope of Insurance and Special Hazards:** The insurance obtained, which is described above, shall provide adequate protection for the Contractor and his/her subcontractors, respectively, against damage claims that may arise from operations under this contract, whether such operations be by the insured or by anyone directly or indirectly employed by him/her and also against any of the special hazards that may be encountered in the performance of this Contract.

(d) **Proof of Carriage of Insurance:** The Contractor shall furnish the Owner with certificates showing the type, amount, class of operations covered, effective dates, and dates of expiration of applicable insurance policies.

14. CONTRACT SECURITY BONDS

(a) If the amount of this Contract exceeds \$150,000, the Contractor shall furnish a performance bond in an amount at least equal to one hundred percent (100%) of the Contract price as security for the faithful performance of this Contract and also a payment bond in an amount equal to one hundred percent (100%) of the Contract price or in a penal sum not less than that prescribed by State, Territorial, or local law, as security for the payment of all persons performing labor on the Work under this Contract and furnishing materials in connection with this Contract. The performance bond and the payment bond may be in one or in separate instruments in accordance with local law. Before final acceptance, each bond must be approved by EDA. If the amount of this Contract does not exceed \$150,000, the Owner shall specify the amount of the payment and performance bonds.

(b) All bonds shall be in the form prescribed by the Contract Documents except as otherwise provided in applicable laws or regulations, and shall be executed by such sureties as are named in the current list of *Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies* as published in Treasury Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent must be accompanied by a certified copy of the agent's

authority to act. Surety companies executing the bonds must also be authorized to transact business in the state where the Work is located.

15. **LABOR STANDARDS - DAVIS-BACON AND RELATED ACTS**
(as required by section 602 of PWEDA)

(a) **Minimum Wages**

(1) All laborers and mechanics employed or working upon the site of the Work in the construction or development of the Project will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act at 29 C.F.R. part 3, the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at the time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor, which is attached hereto and made a part hereof, regardless of any contractual relationship that may be alleged to exist between the Contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of 29 C.F.R. § 5.5(a)(1)(iv); also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 C.F.R. § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein, provided that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates determined under 29 C.F.R. § 5.5(a)(1)(ii) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(2) (i) Any class of laborers or mechanics to be employed under the Contract, but not listed in the wage determination, shall be classified in conformance with the wage determination. EDA shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(A) The work to be performed by the classification requested is not performed by a classification in the wage determination;

(B) The classification is utilized in the area by the construction industry; and

(C) The proposed wage rate, including any bona fide fringe benefits, bears a

reasonable relationship to the wage rates contained in the wage determination.

(ii) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and EDA or its designee agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by EDA or its designee to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, D.C. 20210.

(iii) In the event the Contractor, the laborers or mechanics to be employed in the classification or their representatives, and EDA or its designee do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), EDA or its designee shall refer the questions, including the views of all interested parties and the recommendation of EDA or its designee, to the Administrator for determination.

(iv) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(2)(ii) or (iii) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(3) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(4) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(b) **Withholding**

EDA or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this Contract or any other federal contract with the same prime Contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the Contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee or helper employed or working on the site of the Work in the construction or development of the Project, all or part of the wages required by the Contract, EDA or its designee may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations

have ceased. EDA or its designee may, after written notice to the Contractor, disburse such amounts withheld for and on account of the Contractor or subcontractor to the respective employees to whom they are due. The Comptroller General shall make such disbursements in the case of direct Davis-Bacon Act contracts.

(c) **Payrolls and basic records**

(1) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the Work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the Work in the construction or development of the Project. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 C.F.R. § 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, the plan or program is financially responsible, and the plan or program has been communicated in writing to the laborers or mechanics affected, and provide records that show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(2) (i) For each week in which Contract work is performed, the Contractor shall submit a copy of all payrolls to the Owner for transmission to EDA or its designee. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 C.F.R. part 5.5(a)(3)(i). This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose. It may be purchased from the Superintendent of Documents (Federal Stock Number 029-005-00014-1), U.S. Government Printing Office, Washington, D.C. 20402; or downloaded from the U.S. Department of Labor's website at <https://www.dol.gov/whd/forms/wh347.pdf>. The prime Contractor is responsible for the submission of copies of payrolls by all subcontractors

(ii) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the Contract and shall certify the following:

(A) That the payroll for the payroll period contains the information required to be maintained under 29 C.F.R. § 5.5(a)(3)(i) and that such information is correct and complete;

(B) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the Contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in 29 C.F.R. part 3; and

(C) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the Contract.

(iii) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 15(c)(2)(ii) of this section.

(iv) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under section 1001 of Title 18 and section 3729 of Title 31 of the U.S. Code.

(3) The Contractor or subcontractor shall make the records required under paragraph 15(c)(1) of this section available for inspection, copying, or transcription by authorized representatives of EDA or its designee or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, EDA or its designee may, after written notice to the Contractor or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 C.F.R. § 5.12.

(d) **Apprentices and Trainees.**

(1) **Apprentices.** Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training (Bureau), or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any

apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a Contractor is performing construction on a Project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(2) **Trainees.** Except as provided in 29 C.F.R. § 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program that has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman's hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(3) **Equal employment opportunity.** The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity

requirements of Executive Order 11246, *Equal Employment Opportunity*, as amended, and 29 C.F.R. part 30.

(e) **Compliance with Copeland Anti-Kickback Act Requirements.** The Contractor shall comply with the Copeland Anti-Kickback Act (18 U.S.C. § 874 and 40 U.S.C. § 3145) as supplemented by Department of Labor regulations (29 C.F.R. part 3, “Contractors and Subcontractors on Public Buildings or Public Works Financed in Whole or in Part by Loans or Grants of the United States”). The Act provides that the Contractor and any subcontractors shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which they are otherwise entitled. The Owner shall report all suspected or reported violations to EDA.

(f) **Subcontracts.** The Contractor and any subcontractors will insert in any subcontracts the clauses contained in 29 C.F.R. §§ 5.5(a)(1) through (10) and such other clauses as EDA or its designee may require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime Contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 C.F.R. § 5.5.

(g) **Contract termination; debarment.** The breach of the contract clauses in 29 C.F.R. § 5.5 may be grounds for termination of the contract, and for debarment as a Contractor and a subcontractor as provided in 29 C.F.R. § 5.12.

(h) **Compliance with Davis-Bacon and Related Act Requirements.** All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 C.F.R. parts 1, 3, and 5 are herein incorporated by reference in this contract.

(i) **Disputes concerning labor standards.** Disputes arising out of the labor standards provisions of this Contract shall not be subject to the general disputes clause of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 C.F.R. parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and EDA or its designee, the U.S. Department of Labor, or the employees or their representatives.

(j) **Certification of Eligibility.**

(1) By entering into this Contract, the Contractor certifies that neither it nor any person or firm that has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 C.F.R. § 5.12(a)(1).

(2) No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 C.F.R. § 5.12(a)(1).

(3) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. § 1001.

16. **LABOR STANDARDS - CONTRACT WORK HOURS AND SAFETY STANDARDS ACT**

As used in this paragraph, the terms “laborers” and “mechanics” include watchmen and guards.

(a) **Overtime requirements.** No Contractor or subcontractor contracting for any part of the Contract work, which may require or involve the employment of laborers or mechanics, shall require or permit any such laborer or mechanic in any workweek in which that person is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(b) **Violation; liability for unpaid wages, liquidated damages.** In the event of any violation of the clause set forth in paragraph (a) of this section, the Contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such Contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a) of this section.

(c) **Withholding for unpaid wages and liquidated damages.** EDA or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any monies payable on account of work performed by the Contractor or subcontractor under any such Contract or any other federal contract with the same prime Contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime Contractor such sums as may be determined to be necessary to satisfy any liabilities of such Contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b) of this section.

(d) **Subcontracts.** The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (a) through (c) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime Contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a) through (c) of this section.

17. **EQUAL EMPLOYMENT OPPORTUNITY**

(a) The Recipient hereby agrees that it will incorporate or cause to be incorporated into any contract for construction work, or modification thereof, as defined in the regulations of the Secretary of Labor at 41 C.F.R. chapter 60, which is paid for in whole or in part with funds obtained from EDA, the following equal opportunity clause:

During the performance of this contract, the Contractor agrees as follows:

Economic Development Administration
Contracting Provisions for Construction Projects

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training including apprenticeship. The Contractor agrees to post in conspicuous places available to employees and applicants for employment notices to be provided setting forth the provisions of this nondiscrimination clause.

(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

(3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

(4) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers representatives of the Contractor's commitments hereunder, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(5) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965 and of the rules, regulations, and relevant orders of the Secretary of Labor.

(6) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by EDA and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(7) In the event of the Contractor's noncompliance with the nondiscrimination clauses of

this Contract or with any of the said rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally-assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation or order of the Secretary of Labor, or as otherwise provided by law.

(8) The Contractor will include the portion of the sentence immediately preceding paragraph 17(a)(1) and the provisions of paragraphs 17(a)(1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as EDA or the Secretary of Labor may direct as a means of enforcing such provisions, including sanctions for noncompliance. Provided, however, that in the event the Contractor becomes involved in or is threatened with litigation with a subcontractor or vendor as a result of such direction by EDA or the Secretary of Labor, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

(9) The Recipient further agrees that it will be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally-assisted construction work. Provided, however, that if the Recipient so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality, or subdivision of such government that does not participate in work on or under the Contract.

(10) The Recipient agrees that it will assist and cooperate actively with EDA and the Secretary of Labor in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary of Labor, that it will furnish EDA and the Secretary of Labor such information as they may require for the supervision of such compliance, and that it will otherwise assist EDA in the discharge of the EDA's primary responsibility for securing compliance.

(11) The Recipient further agrees that it will refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a Contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive Order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by EDA or the Secretary of Labor pursuant to Part II, Subpart D of the Executive Order. In addition, the Recipient agrees that if it fails or refuses to comply with these undertakings, EDA may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this EDA financial assistance; refrain from extending any further assistance to the applicant under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such applicant; and refer the case

to the Department of Justice for appropriate legal proceedings.

(b) Exemptions to Above Equal Opportunity Clause (41 C.F.R. chapter 60):

(1) Contracts and subcontracts not exceeding \$10,000 (other than Government bills of lading, and other than contracts and subcontracts with depositories of Federal funds in any amount and with financial institutions which are issuing and paying agents for U.S. savings bonds and savings notes) are exempt. The amount of the Contract, rather than the amount of the federal financial assistance, shall govern in determining the applicability of this exemption.

(2) Except in the case of subcontractors for the performance of construction work at the site of construction, the clause shall not be required to be inserted in subcontracts below the second tier.

(3) Contracts and subcontracts not exceeding \$10,000 for standard commercial supplies or raw materials are exempt.

18. **CONTRACTING WITH SMALL, MINORITY AND WOMEN'S BUSINESSES**

(a) If the Contractor intends to let any subcontracts for a portion of the work, the Contractor shall take affirmative steps to assure that small, minority and women's businesses are used when possible as sources of supplies, equipment, construction, and services.

(b) Affirmative steps shall consist of:

(1) Placing qualified small and minority businesses and women's business enterprises on solicitation lists;

(2) Ensuring that small and minority businesses and women's business enterprises are solicited whenever they are potential sources;

(3) Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses and women's business enterprises;

(4) Establishing delivery schedules, where the requirements of the contract permit, which encourage participation by small and minority businesses and women's business enterprises;

(5) Using the services and assistance of the U.S. Small Business Administration, the Minority Business Development Agency of the U.S. Department of Commerce, and State and local governmental small business agencies;

(6) Requiring each party to a subcontract to take the affirmative steps of this section; and

(7) The Contractor is encouraged to procure goods and services from labor surplus area firms.

19. **HEALTH, SAFETY, AND ACCIDENT PREVENTION**

(a) In performing this contract, the Contractor shall:

(1) Ensure that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to their health and/or safety as determined under construction safety and health standards promulgated by the Secretary of Labor by regulation;

(2) Protect the lives, health, and safety of other persons;

(3) Prevent damage to property, materials, supplies, and equipment; and

(4) Avoid work interruptions.

(b) For these purposes, the Contractor shall:

(1) Comply with regulations and standards issued by the Secretary of Labor at 29 C.F.R. part 1926. Failure to comply may result in imposition of sanctions pursuant to the Contract Work Hours and Safety Standards Act (40 U.S.C. §§ 3701 – 3708); and

(2) Include the terms of this clause in every subcontract so that such terms will be binding on each subcontractor.

(c) The Contractor shall maintain an accurate record of exposure data on all accidents incident to work performed under this Contract resulting in death, traumatic injury, occupational disease, or damage to property, materials, supplies, or equipment, and shall report this data in the manner prescribed by 29 C.F.R. part 1904.

(d) The Owner shall notify the Contractor of any noncompliance with these requirements and of the corrective action required. This notice, when delivered to the Contractor or the Contractor's representative at the site of the Work, shall be deemed sufficient notice of the noncompliance and corrective action required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to take corrective action promptly, the Owner may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. The Contractor shall not base any claim or request for equitable adjustment for additional time or money on any stop order issued under these circumstances.

(e) The Contractor shall be responsible for its subcontractors' compliance with the provisions of this clause. The Contractor shall take such action with respect to any subcontract as EDA, or the Secretary of Labor shall direct as a means of enforcing such provisions.

20. **CONFLICT OF INTEREST AND OTHER PROHIBITED INTERESTS**

(a) No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept, or approve, or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction or material supply contract or any subcontract in connection with the construction of the Project, shall become directly or indirectly interested personally in this Contract or in any part hereof.

(b) No officer, employee, architect, attorney, engineer, or inspector of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the Project, shall become directly or indirectly interested personally in this Contract or in any part thereof, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the Project.

(c) The Contractor may not knowingly contract with a supplier or manufacturer if the individual or entity who prepared the Contract Documents has a corporate or financial affiliation with the supplier or manufacturer.

(d) The Owner's officers, employees, or agents shall not engage in the award or administration of this Contract if a conflict of interest, real or apparent, may be involved. Such a conflict may arise when: (i) the employee, officer or agent; (ii) any member of their immediate family; (iii) their partner or (iv) an organization that employs, or is about to employ, any of the above, has a financial interest in the Contractor. The Owner's officers, employees, or agents shall neither solicit nor accept gratuities, favors, or anything of monetary value from the Contractor or subcontractors.

(e) If the Owner finds after a notice and hearing that the Contractor, or any of the Contractor's agents or representatives, offered or gave gratuities (in the form of entertainment, gifts, or otherwise) to any official, employee, or agent of the Owner or EDA in an attempt to secure this Contract or favorable treatment in awarding, amending, or making any determinations related to the performance of this Contract, the Owner may, by written notice to the Contractor, terminate this Contract. The Owner may also pursue other rights and remedies that the law or this Contract provides. However, the existence of the facts on which the Owner bases such findings shall be an issue and may be reviewed in proceedings under the dispute resolution provisions of this Contract.

(f) In the event this Contract is terminated as provided in paragraph (e) of this section, the Owner may pursue the same remedies against the Contractor as it could pursue in the event of a breach of this Contract by the Contractor. As a penalty, in addition to any other damages to which it may be entitled by law, the Owner may pursue exemplary damages in an amount (as determined by the Owner) which shall not be less than three nor more than ten times the costs the Contractor incurs in providing any such gratuities to any such officer or employee.

21. RESTRICTIONS ON LOBBYING

(a) This Contract, or subcontract is subject to 31 U.S.C. § 1352, regarding lobbying restrictions. The section is explained in the common rule, 15 C.F.R. part 28 (55 FR 6736-6748, February 26, 1990). Each bidder under this Contract or subcontract is generally prohibited from using federal funds for lobbying the Executive or Legislative Branches of the Federal Government in connection with this EDA Award.

(b) **Contract Clause Threshold:** This Contract Clause regarding lobbying must be included in each bid for a contract or subcontract exceeding \$100,000 of federal funds at any tier under the EDA Award.

(c) **Certification and Disclosure:** Each bidder of a contract or subcontract exceeding \$100,000 of federal funds at any tier under the federal Award must file Form CD-512, *Certification Regarding Lobbying – Lower Tier Covered Transactions*, and, if applicable, Standard Form-LLL, *Disclosure of Lobbying Activities*, regarding the use of any nonfederal funds for lobbying. Certifications shall be retained by the Contractor or subcontractor at the next higher tier. All disclosure forms, however, shall be forwarded from tier to tier until received by the Recipient of the EDA Award, who shall forward all disclosure forms to EDA.

(d) **Continuing Disclosure Requirement:** Each Contractor or subcontractor that is subject to the Certification and Disclosure provision of this Contract Clause is required to file a disclosure form at the end of each calendar quarter in which there occurs any event that requires disclosure or that materially affects the accuracy of the information contained in any disclosure form previously filed by such person. Disclosure forms shall be forwarded from tier to tier until received by the Recipient of the EDA Award, who shall forward all disclosure forms to EDA.

(e) **Indian Tribes, Tribal Organizations, or Other Indian Organizations:** Indian tribes, tribal organizations, or any other Indian organizations, including Alaskan Native organizations, are excluded from the above lobbying restrictions and reporting requirements, but only with respect to expenditures that are by such tribes or organizations for lobbying activities permitted by other federal law. An Indian tribe or organization that is seeking an exclusion from Certification and Disclosure requirements must provide EDA with the citation of the provision or provisions of federal law upon which it relies to conduct lobbying activities that would otherwise be subject to the prohibitions in and to the Certification and Disclosure requirements of 31 U.S.C. § 1352, preferably through an attorney's opinion. Note, also, that a non-Indian subrecipient, contractor, or subcontractor under an award to an Indian tribe, for example, is subject to the restrictions and reporting requirements.

22. HISTORICAL AND ARCHAEOLOGICAL DATA PRESERVATION

The Contractor agrees to facilitate the preservation and enhancement of structures and objects of historical, architectural or archaeological significance and when such items are found and/or unearthed during the course of project construction. Any excavation by the Contractor that uncovers an historical or archaeological artifact shall be immediately reported to the Owner and a representative of EDA. Construction shall be temporarily halted pending the notification process and further directions issued by EDA after consultation with the State Historic

Preservation Officer (SHPO) for recovery of the items. *See* the National Historic Preservation Act of 1966 (54 U.S.C. § 300101 *et seq.*, formerly at 16 U.S.C. § 470 *et seq.*) and Executive Order No. 11593 of May 31, 1971.

23. **CLEAN AIR AND WATER**

Applicable to Contracts in Excess of \$150,000

(a) **Definition.** “Facility” means any building, plant, installation, structure, mine, vessel, or other floating craft, location, or site of operations, owned, leased, or supervised by the Contractor or any subcontractor, used in the performance of the Contract or any subcontract. When a location or site of operations includes more than one building, plant, installation, or structure, the entire location or site shall be deemed a facility except when the Administrator, or a designee, of the United States Environmental Protection Agency (EPA) determines that independent facilities are collocated in one geographical area.

(b) In compliance with regulations issued by the EPA, 2 C.F.R. part 1532, pursuant to the Clean Air Act, as amended (42 U.S.C. § 7401 *et seq.*); the Federal Water Pollution Control Act, as amended (33 U.S.C. § 1251 *et seq.*); and Executive Order 11738, the Contractor agrees to:

(1) Not utilize any facility in the performance of this contract or any subcontract which is listed on the Excluded Parties List System, part of the System for Award Management (SAM), pursuant to 2 C.F.R. part 1532 for the duration of time that the facility remains on the list;

(2) Promptly notify the Owner if a facility the Contractor intends to use in the performance of this contract is on the Excluded Parties List System or the Contractor knows that it has been recommended to be placed on the List;

(3) Comply with all requirements of the Clean Air Act and the Federal Water Pollution Control Act, including the requirements of section 114 of the Clean Air Act and section 308 of the Federal Water Pollution Control Act, and all applicable clean air and clean water standards; and

(4) Include or cause to be included the provisions of this clause in every subcontract and take such action as EDA may direct as a means of enforcing such provisions.

24. **USE OF LEAD-BASED PAINTS ON RESIDENTIAL STRUCTURES**

(a) If the work under this Contract involves construction or rehabilitation of residential structures over \$5,000, the Contractor shall comply with the Lead-based Paint Poisoning Prevention Act (42 U.S.C. § 4831). The Contractor shall assure that paint or other surface coatings used in a residential property does not contain lead equal to or in excess of 1.0 milligram per square centimeter or 0.5 percent by weight or 5,000 parts per million (ppm) by weight. For purposes of this section, “residential property” means a dwelling unit, common areas, building exterior surfaces, and any surrounding land, including outbuildings, fences and play equipment affixed to the land, belonging to an owner and available for use by residents, but not

including land used for agricultural, commercial, industrial or other non-residential purposes, and not including paint on the pavement of parking lots, garages, or roadways.

- (b) As a condition to receiving assistance under PWEDA, recipients shall assure that the restriction against the use of lead-based paint is included in all contracts and subcontracts involving the use of federal funds.

25. **ENERGY EFFICIENCY**

The Contractor shall comply with all standards and policies relating to energy efficiency which are contained in the energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C. § 6201) for the State in which the Work under the Contract is performed.

26. **ENVIRONMENTAL REQUIREMENTS**

When constructing a Project involving trenching and/or other related earth excavations, the Contractor shall comply with the following environmental constraints:

- (1) **Wetlands.** When disposing of excess, spoil, or other construction materials on public or private property, the Contractor shall not fill in or otherwise convert wetlands.
- (2) **Floodplains.** When disposing of excess, spoil, or other construction materials on public or private property, the Contractor shall not fill in or otherwise convert 100 year floodplain areas delineated on the latest Federal Emergency Management Agency (FEMA) Floodplain Maps, or other appropriate maps, i.e., alluvial soils on Natural Resource Conservation Service (NRCS) Soil Survey Maps.
- (3) **Endangered Species.** The Contractor shall comply with the Endangered Species Act, which provides for the protection of endangered and/or threatened species and critical habitat. Should any evidence of the presence of endangered and/or threatened species or their critical habitat be brought to the attention of the Contractor, the Contractor will immediately report this evidence to the Owner and a representative of EDA. Construction shall be temporarily halted pending the notification process and further directions issued by EDA after consultation with the U.S. Fish and Wildlife Service.

27. **DEBARMENT, SUSPENSION, INELIGIBILITY, AND VOLUNTARY EXCLUSIONS**

As required by Executive Orders 12549 and 12689, *Debarment and Suspension*, 2 C.F.R. Part 180 and implemented by the Department of Commerce at 2 C.F.R. part 1326, for prospective participants in lower tier covered transactions (except subcontracts for goods or services under the \$25,000 small purchase threshold unless the subrecipient will have a critical influence on or substantive control over the award), the Contractor agrees that:

- (1) By entering into this Contract, the Contractor and subcontractors certify, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared Economic Development Administration Contracting Provisions for Construction Projects

ineligible, or voluntarily excluded from participation in this Contract by any federal department or agency.

(2) Where the Contractor or subcontractors are unable to certify to any of the statements in this certification, the Contractor or subcontractors shall attach an explanation to this bid.

See also 2 C.F.R. part 180 and 2 C.F.R. § 200.342.

28. **EDA PROJECT SIGN**

The Contractor shall supply, erect, and maintain in good condition a Project sign according to the specifications provided by EDA. To the extent practical, the sign should be a free standing sign. Project signs shall not be located on public highway rights-of-way. Location and height of signs will be coordinated with the local agency responsible for highway or street safety in the Project area, if any possibility exists for obstructing vehicular traffic line of sight. Whenever the EDA site sign specifications conflict with State law or local ordinances, the EDA Regional Director will permit such conflicting specifications to be modified so as to comply with State law or local ordinance.

29. **BUY AMERICA**

To the greatest extent practicable, contractors are encouraged to purchase American-made equipment and products with funding provided under EDA financial assistance awards.

**ECONOMIC DEVELOPMENT ADMINISTRATION
CHANGE ORDER FORM**

EDA Award Number: _____ Date: _____

Recipient: _____

Co-Recipient(s): _____

Recipient's Authorized Representative: _____
Name & Phone Number

Construction Contract No.	Contractor Name	Change Order No.

The Change Order will provide for the following:

Change Order Justification (Include cost analysis, if not unit cost in bid proposal or schedule of values):

	TOTAL	EDA Eligible Amount	Non-EDA Eligible Amount
Original Contract Amount	\$	\$	\$
Current Contract Amount adjusted by previous Change Orders	\$	\$	\$
This Change Order will _____(increase) _____(decrease) the Contract Amount by:	\$	\$	\$
The original, scheduled date of completion is/was:			
The new Contract Amount including this Change Order will be:	\$	\$	\$
The Contract Time will _____(increase) _____(decrease) the schedule by:	calendar days	calendar days	calendar days
The estimated date for completion of all work is:	(Date)	(Date)	(Date)

Prepared By (Signature)

Date

Prepared By (Typed or Written Name & Title)

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Specification and drawing conventions.

B. Related Requirements:

- 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: Delaware Technical Community College Automotive Center of Excellence.

- 1. Project Location: Owens Campus, DTCC, Georgetown, Delaware.

- B. Owner: : Delaware Technical Community College.

- C. Architect: Becker Morgan Group, Inc. (BMG), Salisbury, Maryland.

- D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

- 1. Civil Engineer: Becker Morgan Group, Inc. (BMG), Dover, Delaware.
- 2. Structural Engineer: : Becker Morgan Group, Inc. (BMG), Salisbury, Maryland.
- 3. MEP Engineer: Gipe Associates, Inc., Easton, Maryland.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents.

1.5 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

- 1. 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. 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. 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.
 3. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300 - 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. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 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.
 - 2. Include as part of each alternate all costs of related coordination, modification or adjustment.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. DEDUCT ALTERNATE ONE – REDUCE HEIGHT OF SIX OVERHEAD DOORS

1. BASE BID: Provide specified 18' high overhead doors at six locations noted on drawings.
2. ALTERNATE: In lieu of 18' high overhead doors, provide 12' high overhead doors at six locations noted on drawings.

B. DEDUCT ALTERNATE TWO – FRP IN TOILET ROOMS

1. BASE BID: Provide specified FRP in Women 111 and Men 112.
2. ALTERNATE: In lieu of FRP, provide abuse resistant drywall in Women 111 and Men 112.

C. DEDUCT ALTERNATE THREE – SKYLIGHTS

1. BASE BID: Provide skylights as specified and shown on drawings.
2. ALTERNATE: Provide no skylights.

D. DEDUCT ALTERNATE FOUR – CHARGING STATIONS

1. BASE BID: Provide two charging stations as noted on drawings.
2. ALTERNATE: In lieu of two charging stations, provide only conduit for two future charging stations as noted on drawings.

E. DEDUCT ALTERNATE FIVE – PARKING SPACES

1. BASE BID: Provide parking as designated on drawings.
2. DEDUCT ALTERNATE "A": Of the total number of parking spaces, provide seventeen parking spaces, surfaced with crusher run, as designated on drawings.
3. ALTERNATE "B": Eliminate seventeen parking spaces, as designated on drawings.

F. DEDUCT ALTERNATE SIX – ROOF PANEL TYPES

1. BASE BID: Provide Foamed-Insulation-Core Standing Seam Roof Panels as specified.
2. ALTERNATE: In lieu of Foamed-Insulation-Core Standing Seam Roof Panels, provide Standing Seam Roof Panels with batt insulation.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Division 01 Section "Alternates" for products selected under an alternate.
 - 2. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 3. Divisions 02 through 33 Sections for specific requirements and limitations for substitutions.

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.
 - 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 comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.

- g. List of similar installations for completed projects with project names and addresses 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.
 - 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 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.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.

- d. Requested substitution has received necessary approvals of authorities having jurisdiction.
- e. Requested substitution is compatible with other portions of the Work.
- f. Requested substitution has been coordinated with other portions of the Work.
- g. Requested substitution provides specified warranty.
- h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections include the following:
 - 1. Division 01 Section "Unit Prices" for administrative requirements for using unit prices.
 - 2. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after 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."

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. Proposal Requests issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes 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.
 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.
- C. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

1.5 ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
1. Include installation costs in purchase amount only where indicated as part of the allowance.
 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.
1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

3. Representatives from the Owner's funding source (MTA) must concur with scope and pricing on all change order requests prior to final approval. A detailed cost analysis shall be included with the change order request for review by MTA.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701-2001.

1.7 CONSTRUCTION CHANGE DIRECTIVE

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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 "Unit Prices" for administrative requirements governing use of unit prices.
 - 3. 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, including the following:
 - a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule.
 - c. Contractor's Construction Schedule.
 - 2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- 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. Submit draft of AIA Document G703-1992 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.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 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 several line items for principal subcontract amounts, where appropriate.
 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. 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.
 10. 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 paid for by Owner.
 - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, 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.
- C. Payment Application Forms: Use AIA Document G702-1992 and AIA Document G703-1992 Continuation Sheets as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. 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 of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit 3 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.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
 - 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. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 - 5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- G. 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. Schedule of unit prices.
 6. Submittals Schedule (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. List of Contractor's principal consultants.
 9. Copies of building permits.
 10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 11. Initial progress report.
 12. Report of preconstruction conference.
 13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire Owner's insurance.
 16. Initial settlement survey and damage report if required.
- H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: 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 G706-1994, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A-1994, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707-1994, "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 Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Coordination Drawings.
 - 2. Administrative and supervisory personnel.
 - 3. Project meetings.
 - 4. Requests for Interpretation (RFIs).
- 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 "Submittal Procedures" for coordinating Submittals.

1.3 DEFINITIONS

- A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.4 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 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 for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and 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. Project closeout activities.
 8. Startup and adjustment of systems.
 9. Project closeout activities.
- D. 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.

1.5 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
 1. 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:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequences.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
3. Number of Copies: Submit two opaque copies of each submittal. Architect will return one copy.
 - a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.
4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

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 telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.6 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.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

- a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for RFIs.
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Preparation of Record Documents.
 - l. Use of the premises.
 - m. Work restrictions.
 - n. Owner's occupancy requirements.
 - o. Responsibility for temporary facilities and controls.
 - p. Construction waste management and recycling.
 - q. Parking availability.
 - r. Office, work, and storage areas.
 - s. Equipment deliveries and priorities.
 - t. First aid.
 - u. Security.
 - v. Progress cleaning.
 - w. Working hours.
3. Minutes: Record and distribute meeting minutes.
- C. Preinstallation Conferences: 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. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written recommendations.
 - n. Warranty requirements.
 - o. Compatibility of materials.

- p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
- 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to 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 Meetings: Conduct progress meetings at appropriate intervals but not less than monthly. 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.
 - 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) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.

- 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) RFIs.
 - 16) Status of proposal requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
3. Minutes: Record the meeting minutes.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

1.8 REQUESTS FOR INTERPRETATION (RFIs)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
 1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
 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. Date.
 3. Name of Contractor.
 4. Name of Architect.
 5. RFI number, numbered sequentially.
 6. Specification Section number and title and related paragraphs, as appropriate.
 7. Drawing number and detail references, as appropriate.
 8. Field dimensions and conditions, as appropriate.
 9. 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.
 10. Contractor's signature.
 11. 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. Software-Generated RFIs: Software-generated form from project website.
 - 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow ten (10) working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following 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 coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Architect's actions on submittals.
 - f. Incomplete RFIs or RFIs with numerous errors.
 - 2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
 - 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. 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.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly. Include the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Architect.
 - 4. RFI number including RFIs that were dropped and not submitted.
 - 5. RFI description.
 - 6. Date the RFI was submitted.
 - 7. Date Architect's response was received.

1.9 PROJECT WEBSITE

- A. Use Architect's Project Website for purposes of hosting and managing project communication and documentation until Final Completion. Project Website shall include the following functions:
 - 1. Project directory.
 - 2. RFI forms and logs.

3. Task and issue management.
4. Submittals forms and logs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

- 1. Preliminary 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 "Submittal Procedures" for submitting schedules and reports.
- 4. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 SUBMITTALS

- A. 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.

- B. Preliminary Construction Schedule: Submit two opaque copies.

- 1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.

- C. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.
- D. Daily Construction Reports: Submit two copies at monthly intervals.
- E. Material Location Reports: Submit two copies at monthly intervals.
- F. Field Condition Reports: Submit two copies at time of discovery of differing conditions.
- G. Special Reports: Submit two copies at time of unusual event.

1.4 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 bar-chart schedule. 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 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

- B. Time Frame: Extend schedule from date established for commencement of the Work to dates of Substantial and Final Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story 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 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.
 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 fourteen days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in 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 Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.

- b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
8. Area Separations: 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. Permanent space enclosure.
 - c. Completion of mechanical installation.
 - d. Completion of electrical installation.
 - e. Substantial Completion.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- F. 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.
- 2.3 PRELIMINARY CONSTRUCTION SCHEDULE
- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for commencement of the Work.
 - B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- 2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
 - B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.5 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.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (refer to special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial Completions and occupancies.
 19. Substantial Completions authorized.
 20. OSHA/Safety logs
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. 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.

2.6 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. 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 Actual Completion percentage for each activity.

- B. Distribution: Distribute copies of approved schedule to Architect 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.

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections:
 - 1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Division 01 Section "Project Management and Coordination".
 - 3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 5. Division 01 Section "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's 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. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- 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. Project Website: Internet website, requiring user name and password for log in, used for the controlled transmission and exchange of project-related information and data including

Requests for Information, Submittals, Field Bulletins, etc., between Owner, Contractor, Architect, and other authorized parties.

- F. Large-format Submittal: Submittal with page size in excess of 11" x 17".
- G. Complex Submittal: Submittal containing dense diagrams, schedules, tables, or other information difficult to review in electronic format. Examples include door schedule, mechanical equipment schedules, ATC diagrams, electrical panel schedules, etc.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit 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 modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with start-up 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.
 - 1) Revisions shall be provided to Architect and Owner not less than once per month during the submittal process.
 - 2) Contractor may suspend revision of submittal schedule upon completion of required construction-phase submittals, but shall resume revisions at Architect's direction for close-out submittals.
 - 4. Format: Arrange the following information in a tabular format. Contractor shall use Microsoft Excel template file provided by Architect.
 - a. Submittal number.
 - b. Specification Section number
 - c. Specification Section title.
 - d. Scheduled date for first submittal.
 - e. Scheduled date for Architect's final release or approval.
 - f. Description of the Work covered.
 - g. Name of subcontractor.
 - h. Submittal category: Action, informational.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will be made available by Architect for Contractor's use in preparing submittals, upon specific request of the Contractor.

1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

- a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
- b. Digital Drawing Software Program: The Contract Drawings are available in native Microstation V8 XM edition DGN files or converted to AutoCAD 2000 DWG.
- c. Contractor shall execute a data licensing agreement in the form of Agreement included in Project Manual.
- d. Charges for digital data files shall be as described in the data licensing agreement found in Division 00 and shall be the responsibility of the Contractor.
- e. Contractor shall follow the prescribed Digital Data File request procedure.

1) Contractor shall inform Architect that digital data files will be requested, including information required for Architect to complete data licensing agreement.

- a) Name of Contractor.
- b) Name and title of Contractor's agent who will sign form.
- c) Email address and name of person to receive digital data files.
- d) File format: DGN, DWG.
- e) List of drawings for which digital data files are being requested.

2) Architect will provide data licensing agreement to Contractor and indicate charges.

3) Contractor shall sign data licensing agreement and return to Architect along with payment for charges.

4) Upon receipt of signed agreement and payment for charges, Architect will convert files and send to Contractor through project website.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of 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.

- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days average 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 average for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days average for initial review of each submittal.
 - a. All submittals pertaining to work by: Civil, Structural, Fire Protection, Plumbing, Mechanical, and Electrical.
- D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - f. Name of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a dash and then a sequential number (e.g., 061000-01). Resubmittals shall include an alphabetic suffix (e.g., 061000-01A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.

- a. File name shall use project identifier and Specification Section number followed by a dash and then a sequential number (e.g., SCCSC-061000-01.pdf). Resubmittals shall include an alphabetic suffix (e.g., SCCSC-061000-01A.pdf).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Include the following information on an inserted cover sheet:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Name of subcontractor.
 - g. Name of supplier.
 - h. Name of manufacturer.
 - i. Submittal number, including revision identifier.
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - 1) Submittal number and name
 - n. Other necessary identification.
5. Include the following information as keywords in the electronic file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by the Architect.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
 1. Deviations not explicitly noted on submittal and not explicitly approved by Architect shall be considered disapproved regardless of whatever action is indicated for submittal.
- H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will discard submittals received from sources other than Contractor.
 1. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.

- b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Specification Section number and title.
 - i. Indication of full or partial submittal.
 - j. Drawing number and detail references, as appropriate.
 - k. Transmittal number.
 - l. Submittal and transmittal distribution record.
 - m. Remarks.
 - n. Signature of transmitter.
2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- K. 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.
- L. Use for Construction: Use only final submittals that are marked with approval notation from Architect'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 are indicated in individual Specification Sections.
1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project.
 - a. Architect will return annotated file.
 - b. Annotate and retain one copy of file as an electronic Project record document file.
 - c. At conclusion of project, provide one hard copy of annotated electronic Project record document files to Owner.

- 1) Assemble into three ring, D-ring style binders.
 - 2) Collate by specification section and submittal number.
 - 3) Provide tab dividers and label (number only) for each Specification Section.
 - 4) Within each specification section, pages may be printed single or double sided, up to two (2) submittal pages per side of 8 ½" x 11" printed sheet.
2. Large-format and Complex Action Submittals: In addition to PDF electronic files, which shall be the Project record documents, submit two paper copies of each submittal for Architect's use, unless otherwise indicated. Architect will not return copies.
 3. Large-format and Complex Informational Submittals: In addition to PDF electronic files, which shall be the Project record documents, submit two paper copies of each submittal for Architect's use, unless otherwise indicated. Architect will not return copies.
 4. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
 5. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 6. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."
- 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 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.

6. Submit Product Data in the following format:
 - a. PDF electronic file.
 - b. Large-format and Complex Submittals: In addition to the PDF electronic files, two paper copies of Product Data, unless otherwise indicated. Architect will not return copies.

- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based upon Architect's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 42 inches (750 by 1067 mm).
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 - b. Large-format and Complex Submittals: In addition to PDF electronic file, two opaque (bond) copies of each submittal. Architect will not return copies.

- D. 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. Designation used in Contract Drawings and Specifications, if applicable.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 3. 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.
4. 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 not return samples.
 - b. In addition to Samples, submit transmittal form, submittal identification and information sheet, and other relevant information in PDF electronic file. Architect will indicate selection through electronic submittal.
5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- a. Number of Samples: Submit three sets of Samples. Architect will retain one Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project record sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
 - 3) In addition to Samples, submit transmittal form, submittal identification and information sheet, and other relevant information in PDF electronic file. Architect will indicate selection through electronic submittal.
- E. 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.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.

- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- G. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- H. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- I. 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. Use CSI Form 1.5A or equivalent. Include the following information in tabular form:
 - 1. Name, address, and telephone number 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.
 - 4. Submit subcontract list in the following format:
 - a. PDF electronic file.
 - b. Number of Copies: In addition to PDF electronic file, one paper copy of subcontractor list, unless otherwise indicated. Architect will not return copies.
- J. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- K. 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.
- L. 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 American Welding Society (AWS) forms. Include names of firms and personnel certified.
- M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

- Q. 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.
 - R. Product Test Reports: Submit written reports indicating 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.
 - S. 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.
 - T. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."
 - U. 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.
 - V. 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.
 - W. Field Test Reports: Submit 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.
 - X. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
 - Y. Design Data: 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.
- 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. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally-signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

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 Submittals: Refer to requirements in Division 01 Section "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, 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.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
 1. Approved: No further action on submittal is required.
 2. Approved as Noted: Incorporate corrections noted in Work and indicate in record drawings. If notes cannot be incorporated into Work, resubmit the submittal with explanation of why notes cannot be complied with and indicate proposed response to address intent of notes.
 3. Received for Record/Not Reviewed: Submittal provided to satisfy record submittal requirement from previous submittal notes or Contract Documents, or submittal not required and not reviewed. Any notes provided are for Contractor reference and use, but do not imply standard level of review by Architect.
 4. Revise and Resubmit: Incorporate corrections noted in Work and resubmit revised submittal for review.
 5. Disapproved: Submittal does not meet intent of Contract Documents. Correct deficiencies noted and resubmit for review.

- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections include the following:
 - 1. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 2. Divisions 02 through 49 Sections for specific test and inspection requirements.

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. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing,

or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.

- 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. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
- J. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

- A. 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.

1.6 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. 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.
- C. 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.
- D. 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.
- 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 products 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 E 548; 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. 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.
 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.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 2. Notify Architects seven (7) days in advance of dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven (7) days for initial review and each re-review of each mockup.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed, unless otherwise indicated.

1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. 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. 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. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. 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. 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.
- E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the 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.

- F. Associated 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.
- G. 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.

1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, 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 Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. 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 reference during normal working hours.

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.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

- 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 Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
 - 1. AABC - Associated Air Balance Council; www.aabc.com.
 - 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 - 3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
 - 4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 - 5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
 - 6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 - 7. ABMA - American Boiler Manufacturers Association; www.abma.com.
 - 8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org
 - 9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
 - 10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 - 11. AF&PA - American Forest & Paper Association; www.afandpa.org.
 - 12. AGA - American Gas Association; www.aga.org.
 - 13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 - 14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 - 15. AI - Asphalt Institute; www.asphaltinstitute.org.
 - 16. AIA - American Institute of Architects (The); www.aia.org.
 - 17. AISC - American Institute of Steel Construction; www.aisc.org.
 - 18. AISI - American Iron and Steel Institute; www.steel.org.
 - 19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
 - 20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 - 21. ANSI - American National Standards Institute; www.ansi.org.
 - 22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
 - 23. APA - APA - The Engineered Wood Association; www.apawood.org.
 - 24. APA - Architectural Precast Association; www.archprecast.org.
 - 25. API - American Petroleum Institute; www.api.org.
 - 26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
 - 27. ARI - American Refrigeration Institute; (See AHRI).
 - 28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
 - 29. ASCE - American Society of Civil Engineers; www.asce.org.
 - 30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
 - 31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
 - 32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
 - 33. ASSE - American Society of Safety Engineers (The); www.asse.org.
 - 34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
 - 35. ASTM - ASTM International; www.astm.org.

36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformance Européenne; <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 - Canadian Standards Association; www.csa.ca.
65. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.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. IAS - International Approval Services; (See CSA).
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
113. ILI - Indiana Limestone Institute of America, Inc.; www.ili.ai.com.
114. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
115. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
116. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
117. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
118. ISO - International Organization for Standardization; www.iso.org.
119. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
120. ITU - International Telecommunication Union; www.itu.int/home.
121. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
122. LMA - Laminating Materials Association; (See CPA).
123. LPI - Lightning Protection Institute; www.lightning.org.
124. MBMA - Metal Building Manufacturers Association; www.mbma.com.
125. MCA - Metal Construction Association; www.metalconstruction.org.
126. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
127. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
128. MHIA - Material Handling Industry of America; www.mhia.org.
129. MIA - Marble Institute of America; www.marble-institute.com.
130. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
131. MPI - Master Painters Institute; www.paintinfo.com.
132. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
133. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
134. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
135. NADCA - National Air Duct Cleaners Association; www.nadca.com.

136. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
137. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
138. NBI - New Buildings Institute; www.newbuildings.org.
139. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
140. NCMA - National Concrete Masonry Association; www.ncma.org.
141. NEBB - National Environmental Balancing Bureau; www.nebb.org.
142. NECA - National Electrical Contractors Association; www.necanet.org.
143. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
144. NEMA - National Electrical Manufacturers Association; www.nema.org.
145. NETA - InterNational Electrical Testing Association; www.netaworld.org.
146. NFHS - National Federation of State High School Associations; www.nfhs.org.
147. NFPA - National Fire Protection Association; www.nfpa.org.
148. NFPA - NFPA International; (See NFPA).
149. NFRC - National Fenestration Rating Council; www.nfrc.org.
150. NHLA - National Hardwood Lumber Association; www.nhla.com.
151. NLGA - National Lumber Grades Authority; www.nlga.org.
152. NOFMA - National Oak Flooring Manufacturers Association; (See NFWA).
153. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
154. NRCA - National Roofing Contractors Association; www.nrca.net.
155. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
156. NSF - NSF International; www.nsf.org.
157. NSPE - National Society of Professional Engineers; www.nspe.org.
158. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
159. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
160. NFWA - National Wood Flooring Association; www.nwfa.org.
161. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
162. PDI - Plumbing & Drainage Institute; www.pdionline.org.
163. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); <http://www.plasa.org>.
164. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
165. RFCI - Resilient Floor Covering Institute; www.rfci.com.
166. RIS - Redwood Inspection Service; www.redwoodinspection.com.
167. SAE - SAE International; www.sae.org.
168. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
169. SDI - Steel Deck Institute; www.sdi.org.
170. SDI - Steel Door Institute; www.steeldoor.org.
171. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
172. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
173. SIA - Security Industry Association; www.siaonline.org.
174. SJI - Steel Joist Institute; www.steeljoist.org.
175. SMA - Screen Manufacturers Association; www.smainfo.org.
176. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
177. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
178. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
179. SPIB - Southern Pine Inspection Bureau; www.spib.org.
180. SPRI - Single Ply Roofing Industry; www.spri.org.
181. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
182. SSINA - Specialty Steel Industry of North America; www.ssina.com.
183. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
184. STI - Steel Tank Institute; www.steeltank.com.
185. SWI - Steel Window Institute; www.steelwindows.com.
186. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
187. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
188. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
189. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.

190. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
191. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
192. TMS - The Masonry Society; www.masonrysociety.org.
193. TPI - Truss Plate Institute; www.tpinst.org.
194. TPI - Turfgrass Producers International; www.turfgrassod.org.
195. TRI - Tile Roofing Institute; www.tilerroofing.org.
196. UL - Underwriters Laboratories Inc.; <http://www.ul.com>.
197. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
198. USAV - USA Volleyball; www.usavolleyball.org.
199. USGBC - U.S. Green Building Council; www.usgbc.org.
200. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
201. 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 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 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. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.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/ccb.
 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. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
 2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
 3. CDHS; California Department of Health Services; (See CDPH).
 4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservicetamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Sections include the following:
 - 1. Division 01 Section "Summary" for limitations on utility interruptions and other work restrictions.
 - 2. Division 01 Section "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
 - 3. Division 01 Section "Execution" for progress cleaning requirements.
 - 4. Divisions 02 through 49 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
 - 5. Division 31 Section "Termite Control" for pest control.

1.3 USE CHARGES

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer service use charges for sewer usage by all entities for construction operations.
- C. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.
- D. Water Service: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

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: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch, 9-gage, 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 concrete bases for supporting posts.
- B. Lumber and Plywood: Comply with requirements in Division 06 Section "Rough Carpentry."
- C. Paint: Comply with requirements in Division 09 painting Sections.

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 construction personnel. Keep office clean and orderly.
- 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. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 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.

PART 3 - EXECUTION

3.1 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 Division 01 Section "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.

3.2 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. Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- D. Heating: Provide temporary heating 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.
- E. 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.
- F. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service overhead, unless otherwise indicated.
 - 2. Connect temporary service to Owner's existing power source, as directed by Owner.
- G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

- H. 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 and computer 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. Architect's office.
 - e. Engineers' offices.
 - f. Owner's office.
 - g. Principal subcontractors' field and home offices.
 - 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- I. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
 - 2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 31 Section "Earth Moving."
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proof rolling, compacting, and testing.
 - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 32 Section "Asphalt Paving."
- C. Parking: Provide temporary parking areas for construction personnel.

- D. 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 nor endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.

- E. Project Identification and Temporary Signs: Provide Project identification and other signs. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
 - 1. Provide one (1) ground mounted project sign on painted plywood, 4 feet by 8 feet, that includes the following information:
 - a. Project: Tri County Council-Bus Maintenance Facility
 - b. Owner: Tri County Council for the Lower Eastern Shore of Maryland
 - c. Architect: Becker Morgan Group, Inc.
 - d. Civil Engineer: Becker Morgan Group, Inc.
 - e. Mechanical, Electrical, Allen & Shariff Engineering, LLC
 - f. Structural Engineer: Morabito Consultants Inc.
 - g. General Contractor: TBD
 - h. Subcontractors: TBD, list each major trade/vendor
 - 2. Submit project sign artwork for confirmation of spelling, titles, colors and fonts, to Architect for approval prior to execution.
 - 3. Provide temporary, directional signs for construction personnel and visitors.
 - 4. Maintain and touchup signs so they are legible at all times.

- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.

- G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that 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."

- B. Temporary Erosion and Sedimentation Control: Comply with requirements specified in Division 31 Section "Site Clearing."

- C. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- D. Tree and Plant Protection: 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.
- E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
- F. Site Enclosure Fence: When excavation begins, 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. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.

3.5 OPERATION, TERMINATION, AND REMOVAL

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

3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This 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; product substitutions; and comparable products.

- B. Related Sections include the following:

1. Division 01 Section "Alternates" for products selected under an alternate.
2. Division 01 Section "References" for applicable industry standards for products specified.
3. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
4. Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise.
 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, 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. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service

performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.4 SUBMITTALS

A. Substitution Requests: Submit PDF through Project Website 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. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

- a. Statement indicating why specified material or product cannot be provided.
- b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
- c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Samples, where applicable or requested.
- f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
- g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
- h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
- i. 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 lack of availability or delays in delivery.
- j. Cost information, including a proposal of change, if any, in the Contract Sum.
- k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- l. 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.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

- a. Form of Acceptance: Change Order.
- b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

- B. Comparable Product Requests: Submit PDF through Project Website 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. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: Architect will indicate approved substitution requests in Addenda to the Bid Documents.
 - b. Use product specified if Architect cannot make a decision on use of a comparable product request within time allocated.
- C. 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, product selected shall be compatible with products previously selected, even if previously selected products were also options.

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. 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 ensure compliance with the Contract Documents and to ensure 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. Store cementitious products and materials on elevated platforms.
 - 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. **Manufacturer's Warranty:** Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. **Special Warranty:** Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 1. **Manufacturer's Standard Form:** Modified to include Project-specific information and properly executed.
 2. Refer to Divisions 02 through 49 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, that are undamaged and, unless otherwise indicated, that 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. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
3. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified 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 provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or

texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.
- B. 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:
 - 1. 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.
 - 2. Requested substitution does not require extensive revisions to the Contract Documents.
 - 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - 4. Substitution request is fully documented and properly submitted.
 - 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
 - 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - 7. Requested substitution is compatible with other portions of the Work.
 - 8. Requested substitution has been coordinated with other portions of the Work.
 - 9. Requested substitution provides specified warranty.

2.3 COMPARABLE PRODUCTS

- A. Conditions: Architect will consider Contractor's request for comparable product 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:
 - 1. Evidence that the proposed product does not require extensive 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.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

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

- B. Related Sections include the following:

- 1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
- 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.

1.3 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. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- D. Certified Surveys: Submit two copies signed by land surveyor.
- E. Final Property Survey: Submit 2 copies showing the Work performed and record survey data.

1.4 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: 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. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

5. 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 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, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

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 dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 3. Inform installers of lines and levels to which they must comply.
 4. Check the location, level and plumb, of every major element as the Work progresses.
 5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and 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: 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.
 - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

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 8 feet in spaces without a suspended ceiling.
- 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 Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. 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.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
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.
- H. 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.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
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 forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend

preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. 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 materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- 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 Substantial Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to 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.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Disposing of non-hazardous construction waste.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for environmental-protection measures during construction.
 - 2. 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. Disposal: Removal off-site of construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.4 PERFORMANCE GOALS

- A. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 percent by weight of total waste generated by the Work.

1.5 SUBMITTALS

- A. Waste Management Plan: Submit 3 copies of plan within 30 days of date established for commencement of the Work.
- B. 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.
- C. 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.

- D. 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.

1.6 QUALITY ASSURANCE

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

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification, and waste reduction work plan. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. 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. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by 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. 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 entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, 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 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Transport waste materials off Owner's property and legally recycle or dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Warranties.
 - 3. Final cleaning.
- B. Related Sections include the following:
 - 1. Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
 - 2. Division 01 Section "Execution" for progress cleaning of Project site.
 - 3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 5. Divisions 03 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.

7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect 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.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies 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.
 - 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.
 - d. Name of Contractor.
 - e. Page number.

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a 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; shampoo 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. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.

- o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

- 1. Operation and maintenance documentation directory.
- 2. Operation manuals for systems, subsystems, and equipment.
- 3. Maintenance manuals for the care and maintenance of products, materials, finishes, systems and equipment.

- 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 03 through 33 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 SUBMITTALS

- A. Initial Submittal: Submit 2 draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. 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.
- B. Final 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 comments. Submit 3 copies of each corrected manual within 15 days of receipt of Architect's comments.

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.

PART 2 - PRODUCTS

2.1 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."

2.2 MANUALS, GENERAL

- 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.
 6. Name and address of Architect.
 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. 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. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

- A. 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 is 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.

B. 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.

C. 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.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUAL

A. 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.

B. 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.

C. 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.

D. 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.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. 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.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. 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 warranty and bond information, as described below.

B. 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.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
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.

D. 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 videotape, if available.
- E. 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.
- F. 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.
- 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 3 - EXECUTION

3.1 MANUAL PREPARATION

- 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. 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.
- C. 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.
- D. 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."
- E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
- B. Related Sections include the following:
 - 1. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Divisions 03 through 33 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
 - 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 prepare the 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 understandable drawing technique.

- c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 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.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders and Record Drawings where applicable.

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 modifications to Project Record Documents as they occur; do not wait until the 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 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

- 1. Demonstration of operation of systems, subsystems, and equipment.
- 2. Training in operation and maintenance of systems, subsystems, and equipment.
- 3. Demonstration and training video recordings.

- B. Related Requirements:

- 1. Divisions 02 through 33 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 list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

- 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

- B. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

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

- 1. Identification: On each copy, provide an applied label with the following information:

- a. Name of Project.
- b. Name and address of videographer.
- c. Name of Architect.
- d. Name of Contractor.
- e. Date of video recording.

- 2. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in PDF electronic file format on compact disc.

- a. Quantity: Three copies in addition to copies included in operations and maintenance manuals.

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.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data 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 for equipment not part of a system, as required by individual Specification Sections, and as follows:
 - 1. Fire-protection systems, including fire alarm, fire pumps, and fire-extinguishing systems.
 - 2. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
 - 3. HVAC instrumentation and controls.
 - 4. Electrical service and distribution, including transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
 - 5. Communication systems, including intercommunication, surveillance, clocks and programming, voice and data, and television equipment.
 - 6. Bus Wash Equipment – Refer to spec sections 110000 & 110001 for training, OAM manuals and maintenance contract requirements.
 - 7. Emergency Generator – Add/Alternate #3
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.

- d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. 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 training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."
- 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. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 1. Schedule training with Owner with at least seven days' advance notice.
- D. 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.

END OF SECTION 017900

SECTION 019113 – GENERAL COMMISSIONING 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 general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.
- B. Related Sections include the following:
 - 1. Division 01 Section "HVAC Commissioning Requirements" for specific requirements for commissioning HVAC systems.
 - 2. Division 01 Section "Electrical Commissioning Requirements" for specific requirements for commissioning electrical systems.
 - 3. Division 01 Section "Plumbing System Commissioning Requirements" for specific requirements for commissioning Plumbing systems.
 - 4. Division 01 Section "Contract Closeout" for specific requirements for closeout at substantial and final completion.
 - 5. Division 01 Section "Contract Closeout" for Specific Requirements for training and demonstration of systems to Owner.
 - 6. Division 01 Section "Contract Closeout" for Specific Requirements related to the Preparation of systems operation and maintenance manuals.

1.3. DEFINITIONS

- A. CxA: Commissioning Authority.
- B. OPR: Owner's Project Requirements.
- C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- D. TAB: Testing, Adjusting, and Balancing.

1.4. COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. All contractor commissioning requirements and costs associated with commissioning the project shall be included in the base bid.
3. Representatives of the facility user and operation and maintenance personnel.
4. Architect and Engineering design professionals.

1.5. OWNER'S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:

1. Coordination meetings.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Testing meetings.
4. Demonstration of operation of systems, subsystems, and equipment.

1.6. CONTRACTOR'S RESPONSIBILITIES

A. Provide utility services required for the commissioning process.

B. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in commissioning and construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in operation and maintenance training sessions.
4. Participate in final review at acceptance meeting.
5. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
7. Review and approve final commissioning documentation.
8. Certify that all pre-test work and pre-testing of functional performance tests are

complete and operational prior to scheduling performed testing by CxA. Submit completed functional performance test forms with data from pre-testing.

9. During functional performance testing, a representative from the mechanical contractor, controls contractor, and test/balance engineer must be present and participate in testing.

C. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Pre-test all systems/equipment prior to engaging CxA for Functional Performance Testing.
2. Participate in commissioning and construction-phase coordination meetings.
3. Participate in maintenance orientation and inspection.
4. Participate in procedures meeting for testing.
5. Participate in final review at acceptance meeting.
6. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
7. Provide information to the CxA for developing construction-phase commissioning plan.
8. Participate in training sessions for Owner's operation and maintenance personnel.
9. Provide updated Project Record Documents to the CxA on a daily basis.
10. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data."
11. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.
12. The test/balance subcontractor, mechanical contractor, and automatic temperature controls subcontractor must be on-site and provide assistance during all functional performance testing.

1.7. CXA'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Prepare a construction-phase commissioning plan. Collaborate with Contractor and with subcontractors to develop test and inspection procedures. Include design changes and scheduled commissioning activities coordinated with overall Project schedule. Identify

commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

- C. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
- D. At a mutually agreed upon time, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.
- E. Observe and inspect construction and report progress and deficiencies. In addition to compliance with the Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.
- F. Prepare Project-specific test and inspection procedures and checklists.
- G. Schedule, direct, witness, and document tests, inspections, and systems startup.
- H. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
- I. Certify date of acceptance and startup for each item of equipment for start of warranty periods.
- J. Review Project Record Documents for accuracy. Request revisions from Contractor to achieve accuracy. Project Record Documents requirements are specified in Division 01 Section "Project Record Documents."
- K. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data."
- L. Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.

1.8. COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.

2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
 3. Identification of systems and equipment to be commissioned.
 4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
 5. Identification of items that must be completed before the next operation can proceed.
 6. Description of responsibilities of commissioning team members.
 7. Description of observations to be made.
 8. Description of requirements for operation and maintenance training, including required training materials.
 9. Description of expected performance for systems, subsystems, equipment, and controls.
 10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
 11. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.
 12. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
 13. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
 14. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
- B. Test Checklists: CxA, with assistance of Contractor and Subcontractors, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist. Specific checklist content requirements are specified in Division 01 Section "HVAC Commissioning Requirements", "Electrical Commissioning Requirements" and "Plumbing System Commissioning Requirements". Test checklists will be jointly developed as the project progresses. Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
1. Name and identification code of tested item.

2. Test number.
 3. Time and date of test.
 4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
 5. Dated signatures of the person performing test and of the witness, if applicable.
 6. Individuals present for test.
 7. Deficiencies.
 8. Issue number, if any, generated as the result of test.
- C. Certificate of Readiness: Certificate of Readiness shall be signed by Contractor, Subcontractor(s), Installer(s), and CxA certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate.
- D. Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
- E. Corrective Action Documents: CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.
- F. Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
1. Creating an Issues Log Entry:
 - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
 - b. Assign a descriptive title of the issue.
 - c. Identify date and time of the issue.
 - d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
 - e. Identify system, subsystem, and equipment to which the issue applies.
 - f. Identify location of system, subsystem, and equipment.
 - g. Include information that may be helpful in diagnosing or evaluating the issue.
 - h. Note recommended corrective action.
 - i. Identify commissioning team member responsible for corrective action.
 - j. Identify expected date of correction.
 - k. Identify person documenting the issue.

2. Documenting Issue Resolution:
 - a. Log date correction is completed or the issue is resolved.
 - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
 - c. Identify changes to the Contract Documents that may require action.
 - d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
 - e. Identify person(s) who corrected or resolved the issue.
 - f. Identify person(s) documenting the issue resolution.
 3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, CxA shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, CxA shall include the following information in the issues log and expand it in the narrative:
 - a. Issue number and title.
 - b. Date of the identification of the issue.
 - c. Name of the commissioning team member assigned responsibility for resolution.
 - d. Expected date of correction.
- G. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:
1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
 2. Commissioning plan.
 3. Testing plans and reports.
 4. Corrective modification documentation.
 5. Issues log.
 6. Completed test checklists.
 7. Listing of off-season test(s) not performed and a schedule for their completion.
 8. All commissioning documents must be submitted to the building Owner within 90 days of the date of receipt of the Certificate of Occupancy.

- H. Systems Manual: CxA shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:
 - 1. Project Record Documents as specified in Division 01 Section "Project Record Documents."
 - 2. Final commissioning plan.
 - 3. Commissioning report.
 - 4. Operation and maintenance data as specified in Division 01 Section "Operation and Maintenance Data."

1.9. SUBMITTALS

- A. Test Checklists and Report Forms: CxA shall submit sample checklists and forms to Contractor quality-control manager and subcontractors for review and comment. Submit two copies of each checklist and report form.
- B. Test and Inspection Reports: CxA shall submit test and inspection reports.
- C. Corrective Action Documents: CxA shall submit corrective action documents.

1.10. QUALITY ASSURANCE

- A. Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- B. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.11. COORDINATION

- A. Coordinating Meetings: CxA shall conduct coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- B. Pretesting Meetings: CxA shall conduct pretest meetings of the commissioning team to review startup reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.
- C. Testing Coordination: CxA shall coordinate sequence of testing 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.
- D. Manufacturers' Field Services: CxA and Contractor shall coordinate services of

manufacturers' field services.

1.12. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.1. OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. In addition to requirements specified in Division 01 Section "Demonstration and Training," perform the following:

1. Review installed systems, subsystems, and equipment.
2. Review instructor qualifications.
3. Review instructional methods and procedures.
4. Review training module outlines and contents.
5. Review course materials (including operation and maintenance manuals).
6. Inspect and discuss locations and other facilities required for instruction.
7. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
8. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

- B. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment as specified in Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 019114- PLUMBING COMMISSIONING 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 requirements for commissioning the plumbing system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

- B. Related Sections include the following:

- 1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

- C. The following systems and/or equipment shall be commissioned:

- 1. Domestic hot water re-circulating system.
- 2. Emergency eyewash/shower systems, mixing valves, and equipment.
- 3. Domestic hot water heaters.
- 4. Backflow preventers.
- 5. Plumbing Fixtures.
- 6. Domestic water meter (including interlock to ATC system).
- 7. Thermostatic mixing valves below hand sinks/lavs.
- 8. Trap priming stations.
- 9. Compressed air systems/equipment.
- 10. Plumbing Pumps.
- 11. High/Low Mixing Valves.

1.3. DEFINITIONS

- A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of plumbing systems, electrical, communications, controls for plumbing systems, and other related systems.
- B. CxA: Commissioning Authority.

- C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- D. TAB: Testing, Adjusting, and Balancing.

1.4. CONTRACTOR'S RESPONSIBILITIES

- A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Contractor:
 - 1. Attend procedures meeting for TAB Work.
 - 2. Certify that TAB Work is complete.
 - 3. Assist performing functional performance tests.
- C. Mechanical Contractor:
 - 1. Attend TAB verification testing.
 - 2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.
 - 3. Assist performing functional performance tests.
- D. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the Contract Documents, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.
- E. TAB Subcontractor:
 - 1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.
 - a. Verify the following:
 - i. Accessibility of equipment and components required for TAB Work.
 - ii. Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
 - iii. Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
 - iv. Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
 - v. Flow rates have been specified and compared to central

- equipment output capacities.
 - b. Identify discontinuities and omissions in the Contract Documents.
 - c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
 - d. Assist performing functional performance tests.
2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation & Controls of HVAC & Plumbing Systems."
- F. Electrical Contractor:
- 1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and plumbing systems, subsystems, and equipment.
 - 2. Attend TAB verification testing.

1.5. COMMISSIONING DOCUMENTATION

- A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."
- B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for plumbing systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:
 - 1. Calibration of sensors and sensor function.
 - 2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
 - 3. Control sequences for plumbing systems.
 - 4. Strength of control signal for each set point at specified conditions.
 - 5. Responses to control signals at specified conditions.
 - 6. Sequence of response(s) to control signals at specified conditions.
 - 7. Electrical demand or power input at specified conditions.
 - 8. Power quality and related measurements.
 - 9. Expected performance of systems, subsystems, and equipment at each step of test.
 - 10. Narrative description of observed performance of systems, subsystems, and

equipment. Notation to indicate whether the observed performance at each step meets the expected results.

11. Interaction of auxiliary equipment.
12. Issues log.

1.6. SUBMITTALS

- A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.
- C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.
- D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
- E. Certified Pipe Cleaning and Flushing Report: CxA shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed.
- F. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.
- G. Corrective Action Documents: CxA shall submit corrective action documents.
- H. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.1. TESTING PREPARATION

- A. Prerequisites for Testing:
 1. Certify that plumbing systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.

2. Certify that plumbing instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.
3. Certify that plumbing procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
8. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
9. Annotate checklist or data sheet when a deficiency is observed.
10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:
 - a. Flow rates for domestic re-circulating systems.
 - b. Temperature for emergency eyewash/shower systems.
 - c. Discharge temperatures of water heaters.
 - d. Re-circ. pump pressures and flow rates.
 - e. Domestic water meter total volume in gallons.
 - f. Flow rates in gallons per minute for showerheads.
 - g. Trap priming station water discharge.
 - h. Water heater temperature and set point.
 - i. Compressor operation including refrigerated air dryers.
 - j. Temperatures leaving all high/low and lavatory mixing valves.
11. Verify proper responses of monitoring and control system controllers and sensors to include the following:
 - a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
 - b. Report deficiencies and prepare an issues log entry.
12. Verify that plumbing equipment field quality-control testing has been completed

and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 22 Sections.

13. Verify flow rates of all aerators.
 14. Verify the operation of all plumbing fixtures.
- B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. Operational modes include the following:
1. Occupied and unoccupied.
 2. Emergency power supply.
 3. Life-safety and safety systems.
 4. Temporary upset of system operation.
 5. Partial occupancy conditions.
 6. Special cycles.
 7. Alarm conditions.
 8. Lead/lag operation where redundant equipment is indicated.
 9. All alarms.

3.2. TAB VERIFICATION

- A. TAB Subcontractor shall coordinate with CxA for work required in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing." TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.
- B. Contractor, Plumbing Contractor, and CxA shall witness TAB Work.
- C. TAB Preparation:
 1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
 - a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.
- D. Verification of Final TAB Report:
 1. CxA shall select, at random, 10 percent of report for field verification.
 2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field

verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item is defined as follows:
 - a. A deviation of more than 10 percent.
4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.
- E. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.
- F. CxA shall certify that TAB Work has been successfully completed.

3.3. TESTING

- A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.
- B. Perform tests using design conditions whenever possible.
 1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
 2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.
 3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.
- C. Scope of Plumbing Contractor Testing:
 1. Testing scope shall include entire plumbing installation, from central hot water heating equipment for heat generation through distribution systems to each fixture. It shall include measuring capacities and effectiveness of operational and control functions.
 2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
 3. Test all plumbing fixtures.
 4. Test time to reach temperature and temperature of hot water at all fixtures with

- thermostatic mixing valves. Also test all high/low mixing valves discharge temperatures.
5. Test discharge of water at all trap priming stations.
 6. Verify that all backflow preventers have been tested. Document in writing.
 7. Test domestic water heaters.
 8. Test operation, set points, and safeties of water heater.
 9. Test discharge of water at all trap priming stations.
 10. Test operation, set points, and safeties of compressed air system.
- D. Detailed Testing Procedures: CxA, with Plumbing Contractor, TAB Subcontractor, and Plumbing Instrumentation and Control Contractor, shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment.
- E. HVAC Instrumentation and Control System Testing:
1. Field testing plans and testing requirements are specified in Division 23 Section "Instrumentation & Controls of HVAC & Plumbing Systems." The CxA, Plumbing Contractor, and the HVAC Instrumentation and Control Contractor shall collaborate to prepare testing plans.
 2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.
- F. Plumbing System Testing: Plumbing Contractor shall prepare a testing plan to verify performance of water heaters, emergency eyewash/shower systems, domestic recirculating systems, backflow preventers, plumbing fixtures, trap priming stations, domestic pumps, compressed air systems, and thermostatic mixing valves. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
 3. Design and actual measurements for all equipment.
- G. Deferred Testing:
1. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test

rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

H. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.
3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION

SECTION 019115 - HVAC COMMISSIONING 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 requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

- B. Related Sections include the following:

- 1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

- C. The following systems and/or equipment shall be commissioned:

- 1. Air Flow Monitoring Stations.
- 2. Automatic Temperature Control System.
- 3. Boilers and burners.
- 4. Condensate overflow alarms.
- 5. Condensate pumps.
- 6. Carbon Monoxide Systems.
- 7. Differential Pressure Bypass Valve.
- 8. Differential Static Pressure Controllers.
- 9. Duct detectors.
- 10. Ductless air conditioning units.
- 11. Energy recovery ventilators (Including variable frequency drives).
- 12. Exhaust air systems including carbon monoxide exhaust systems.
- 13. Exhaust Fans and ventilation fans.
- 14. Flow measuring stations.
- 15. Flow Switches.

16. Freeze protection pumps.
17. High temperature alarms.
18. Hot water systems.
19. Heating and Ventilating Unit.
20. HVAC controls and sequences of operation.
21. Lighting interface to ATC system.
22. Carbon Monoxide Makeup Air Unit.
23. Pumps.
24. Split System Condensing Units.
25. Variable frequency drives.
26. Variable refrigerant volume systems (indoor and outdoor units).
27. Variable refrigerant volume system ATC interface and systems integration.
28. Make-up water meter/ATC interface.

1.3. DEFINITIONS

- A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.
- B. CxA: Commissioning Authority.
- C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- D. TAB: Testing, Adjusting, and Balancing.

1.4. CONTRACTOR'S RESPONSIBILITIES

- A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Contractor:
 1. Attend procedures meeting for TAB Work.
 2. Certify that TAB Work is complete.
 3. Assist performing functional performance tests.

- C. Mechanical Contractor:
 - 1. Attend TAB verification testing.
 - 2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.
 - 3. Assist performing functional performance tests.
- D. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the Contract Documents, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions. Assist with performing functional performance tests.
- E. TAB Subcontractor:
 - 1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.
 - a. Verify the following:
 - i. Accessibility of equipment and components required for TAB Work.
 - ii. Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
 - iii. Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
 - iv. Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
 - v. Air and water flow rates have been specified and compared to central equipment output capacities.
 - b. Identify discontinuities and omissions in the Contract Documents.
 - c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
 - d. Assist performing functional performance tests.
 - 2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation & Controls of HVAC & Plumbing Systems."
- F. Electrical Contractor:
 - 1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.
 - 2. Attend TAB verification testing.

1.5. COMMISSIONING DOCUMENTATION

- A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."
- B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:
 - 1. Calibration of sensors and sensor function.
 - 2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
 - 3. Control sequences for HVAC systems.
 - 4. Strength of control signal for each set point at specified conditions.
 - 5. Responses to control signals at specified conditions.
 - 6. Sequence of response(s) to control signals at specified conditions.
 - 7. Electrical demand or power input at specified conditions.
 - 8. Power quality and related measurements.
 - 9. Expected performance of systems, subsystems, and equipment at each step of test.
 - 10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
 - 11. Interaction of auxiliary equipment.
 - 12. Issues log.

1.6. SUBMITTALS

- A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.
- C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

- D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
- E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.
- F. Corrective Action Documents: CxA shall submit corrective action documents.
- G. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.1. TESTING PREPARATION

- A. Prerequisites for Testing:
 - 1. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.
 - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.
 - 3. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
 - 4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
 - 5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
 - 6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
 - 7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
 - 8. Check safety cutouts, alarms, and interlocks with duct detectors and life-safety systems during each mode of operation.

9. Annotate checklist or data sheet when a deficiency is observed.
10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:
 - a. All temperature alarms.
 - b. All pump status alarms.
 - c. Supply and return flow rates for systems in each operational mode.
 - d. Operation of heat pump units in both heating and cooling cycles.
 - e. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
 - f. Building pressurization.
 - g. Total exhaust airflow and total outdoor-air intake.
 - h. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
 - i. Supply, outside air, exhaust and return air flow rates for ERVs in each operating mode.
 - j. Pump flow rates, pressure and amperage at each operating mode.
 - k. Sequences of operation of all HVAC equipment.
 - l. Ductless heat pumps and air conditioning units with air flow rates, and temperatures.
 - m. Variable speed drive parameters at each operated mode.
 - n. Boiler temperatures, flow rates, low water cut-off interlock, flame failure interlocks, and amperage.
 - o. Supply and return air flow rates for all HVAC equipment.
 - p. Operation/Accuracy of flow measuring stations at various flow rates.
 - q. Operation of variable refrigerant flow systems in all modes.
 - r. Fluid flow rates and temperature for all water cooled equipment.
 - s. Set point and operation of "high temperature" alarms.
 - t. Test operation and air temperatures of hot gas re-heat coils.
 - u. Set point and operation of high temperature alarms.
 - v. Test freeze protection pumps.
 - w. Lighting interface and start/stop by ATC system.
 - x. Carbon monoxide system, makeup air unit, and exhaust air fan operation, temperature, and air flow rates.
 - y. Heating and ventilating unit operation, temperature, and air flow rates.
11. Verify proper responses of monitoring and control system controllers and sensors to include the following:
 - a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
 - b. Report deficiencies and prepare an issues log entry.
12. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.

B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load. Operational modes include the following:

1. Heating/Cooling Mode.
2. Occupied and unoccupied.
3. Warm up and cool down.
4. Economizer cycle.
5. Life-safety and safety systems.
6. Duct detectors.
7. Fire safety.
8. Temporary upset of system operation.
9. Partial occupancy conditions.
10. Special cycles.
11. ERV/supply/exhaust air flow at partial CO₂ levels.
12. Variable refrigerant volume units in heating/cooling modes.
13. Heating and ventilating unit in all modes of operation.
14. Lead/lag modes where redundant equipment is indicated.
15. All alarms.
16. Make-up air unit and exhaust air fan.
17. Flow switch shut-down and alarm.
18. Condensate overflow safety switch shut-down and alarm.
19. Condensate pump operation.

3.2. TAB VERIFICATION

- A. TAB Subcontractor shall coordinate with CxA for work required in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing." TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.
- B. Contractor, HVAC Contractor, and CxA shall witness TAB Work.

- C. TAB Preparation:
 - 1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."
 - a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.
- D. Verification of Final TAB Report:
 - 1. CxA shall select, at random, 10 percent of report for field verification.
 - 2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item is defined as follows:
 - a. For all readings a deviation of more than 10 percent.
 - 4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.
- E. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.
- F. CxA shall certify that TAB Work has been successfully completed.

3.3. TESTING

- A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.
- B. Contractors and subcontractors must pre-inspect and pre-test all equipment and systems prior to requesting functional performance testing by the CxA. All pre-start/start-up checklists and functional performance test forms must be completed and submitted to Engineer prior to scheduling formal functional performance testing.
- C. Perform tests using design conditions whenever possible.
 - 1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
 - 2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.

3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.
- D. Scope of HVAC Contractor Testing:
1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
 2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. Detailed Testing Procedures: CxA, with HVAC Contractor, TAB Subcontractor, and HVAC Instrumentation and Control Contractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
- F. HVAC Instrumentation and Control System Testing:
1. Field testing plans and testing requirements are specified in Division 23 Section "Instrumentation & Controls of HVAC & Plumbing Systems". The CxA, HVAC Contractor, Equipment Provider/Manufacturer and the HVAC Instrumentation and Control Contractor shall collaborate to prepare testing plans.
 2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.
- G. Energy Supply System Testing: HVAC Contractor shall prepare a testing plan to verify performance of gas systems and equipment. Plan shall include the following:
1. Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.
 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
- H. Heat-Generation System Testing: HVAC Contractor shall prepare a testing plan to verify performance of air handling units, heat pumps, and auxiliary equipment, energy recovery ventilators, H&V unit, carbon monoxide makeup air unit, variable refrigerant volume units, unit heaters, radiant heat panels, hot gas re-heat coils. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
 3. Variable refrigerant flow equipment volts, amps, temperatures, and modes of operation.
- I. Refrigeration System Testing: HVAC Contractor shall prepare a testing plan to verify performance of heat pumps, refrigerant compressors, condensers, energy recovery unit, variable refrigerant volume systems, ductless units, condensing units and other refrigeration systems. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
 3. Variable refrigerant flow equipment volts, amps, temperatures, and modes of operation.
- J. HVAC Distribution System Testing: HVAC Contractor shall prepare a testing plan to verify performance of air, air handling units, hydronic distribution systems, special exhaust and ERV unit supply and exhaust and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
 3. Equipment, air flow rates, air temperatures, fluid flow rates, safeties, freeze protection pump operation, and demand controlled ventilation.
- K. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
 2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.
- L. Testing Reports:
1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
 2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.
 3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION

PROJECT MANUAL

Bid Documents
Delaware Technical and Community
College Automotive Center of Excellence
EDA PROJECT #01-01-14801
Georgetown, Delaware

Volume II
DIVISION 00 THROUGH DIVISION 05



ARCHITECTURE
ENGINEERING

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312 West Main Street, Suite 300
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SECTION 024119 - 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 site elements.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
 - 1. Refer to adjacent work in existing building envelope marked N.I.C. Coordinate as required with Construction Manager/General Contractor that is responsible for work in N.I.C. areas.

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 and deliver them to Owner.
- C. Remove and Reinstall: Detach items from existing construction, 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.

1.4 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
- B. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property in addition to items described in Paragraph 1.4-A., demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

1.5 SUBMITTALS

- A. Pre-demolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
- B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

1.6 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. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project with Construction Manager/General Contractor. Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review 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.

1.7 PROJECT CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Construction Manager and Owner. Owner will remove hazardous materials under a separate contract.
- C. Storage or sale of removed items or materials on-site is not permitted.
- D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.9 COORDINATION

- A. It is the intent of this specification in conjunction with the demolition drawings to show the majority of the demolition, but may not show all incidental items required to accommodate the new work. It is the responsibility of the Demolition Contractor to become familiar with the new work and fully coordinate demolition efforts with the new work required.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 2. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
 1. 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.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
 - 1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."
- B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.
 - 2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
 - a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

3.3 PREPARATION

- A. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 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.
- B. Temporary Shoring: 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.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, 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. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
- B. 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.
- C. 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.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 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.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, and other pozzolans materials subject to compliance with requirements.

- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Aggregates.
6. Admixtures:

- a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

7. Vapor retarders.
8. Liquid floor treatments.
9. Curing materials.

10. Joint fillers.

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

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.
8. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
9. Intended placement method.
10. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

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

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

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

1.5 INFORMATIONAL SUBMITTALS

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

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Vapor retarders.
5. Joint-filler strips.

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

1. Portland cement.
2. Fly ash.
3. Slag cement.

4. Blended hydraulic cement.
5. Aggregates.
6. Admixtures:

- C. Research Reports: For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
- D. Preconstruction Test Reports: For each mix design.
- E. Field quality-control reports.
- F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
 1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with **ACI 301 (ACI 301M)** and ACI 306.1.
- B. Hot-Weather Placement: Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)**.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag, Type IP, portland-pozzolan cement.

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

1. Alkali-Silica Reaction: Comply with one of the following:

- a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
- b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
- c. Alkali Content in Concrete: Not more than **4 lb./cu. yd. (2.37 kg/cu. m)** for moderately reactive aggregate or **3 lb./cu. yd. (1.78 kg/cu. m)** for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with **ACI 301 (ACI 301M)**.

2. Maximum Coarse-Aggregate Size: **1 inch (25 mm)** nominal.

3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

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

- D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

- E. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils (0.25 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.4 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.5 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Floor Slab Protective Covering: Eight-feet- (2438-mm-) wide cellulose fabric.

2.7 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
 - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
 - 2. Slag Cement: 50 percent by mass.
 - 3. Total of Fly Ash or Other Pozzolans, Slag Cement: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass.
 - 4. Total of Fly Ash or Other Pozzolans: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: **ACI 318 (ACI 318M) F2**.
2. Minimum Compressive Strength: **3000 psi (20.7 MPa)** at 28 days.
3. Maximum w/cm: 0.50.
4. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing **1-inch (25-mm)** nominal maximum aggregate size.

B. Class B: Normal-weight concrete used for foundation walls and pedestals.

1. Exposure Class: **ACI 318 (ACI 318M) F2**.
2. Minimum Compressive Strength: **4000 psi (27.6 MPa)** at 28 days.
3. Maximum w/cm: 0.45.
4. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing **1-inch (25-mm)** nominal maximum aggregate size.

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

1. Minimum Compressive Strength: **4000 psi (27.6 MPa)** at 28 days.
2. Maximum w/cm: 0.45.
3. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.2 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 2. Face laps away from exposed direction of concrete pour.
 3. Lap vapor retarder over footings and grade beams not less than 6 inches (150 mm), sealing vapor retarder to concrete.
 4. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
 5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches (150 mm) on all sides, and sealing to vapor retarder.

3.3 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points 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 indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3.2 mm)**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3.2-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 2. Terminate full-width joint-filler strips not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.4 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
 - 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 - 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of **ACI 301 (ACI 301M)**, but not to exceed the amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
 - 1. If a section cannot be placed continuously, provide construction joints as indicated.
 - 2. Deposit concrete to avoid segregation.
 - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301 (ACI 301M)**.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches (150 mm)** into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not place concrete floors and slabs in a checkerboard sequence.

2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. **ACI 301 (ACI 301M)** Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than **1-1/2 inches (38 mm)** wide or **1/2 inch (13 mm)** deep.
 - b. Remove projections larger than **1 inch (25 mm)**.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class D.
 - e. Apply to concrete surfaces not exposed to public view.
2. **ACI 301 (ACI 301M)** Surface Finish SF-3.0:
 - a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
 - b. Remove projections larger than **1/8 inch (3 mm)**.
 - c. Patch tie holes.
 - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class A.
 - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish.

B. Related Unformed Surfaces:

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

3.6 FINISHING FLOORS AND SLABS

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

B. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.

2. Continue troweling passes and restraighthen until surface is free of trowel marks and uniform in texture and appearance.
 3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 4. Do not add water to concrete surface.
 5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
 6. 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)] [3/16 inch (4.8 mm)] [1/8 inch (3 mm)] [1/8 inch (3 mm) and]1/16 inch (1.6 mm) in 2 feet (610 mm)].
- C. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
1. Coordinate required final finish with Architect before application.
 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
 2. Coordinate required final finish with Architect before application.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. 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:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated on Drawings, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.8 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 1. Comply with **ACI 301 (ACI 301M)** and ACI 306.1 for cold weather protection during curing.
 2. Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)** for hot-weather protection during curing.
 3. Maintain moisture loss no more than **0.2 lb/sq. ft. x h (1 kg/sq. m x h)**, calculated in accordance with **ACI 305.1**.) before and during finishing operations.
- B. Curing Formed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:
 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
 3. If forms remain during curing period, moist cure after loosening forms.
 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.
- C. Curing Unformed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:
 1. Begin curing immediately after finishing concrete.
 2. Interior Concrete Floors:

- a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12-inches (300-mm).
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- b. Floors to Receive Curing Compound:
 - 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Maintain continuity of coating, and repair damage during curing period.
 - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[**unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project**].
- c. Floors to Receive Curing and Sealing Compound:
 - 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.9 TOLERANCES

- A. Conform to **ACI 117** (ACI 117M).

3.10 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than seven days' old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
 4. Rinse with water; remove excess material until surface is dry.
 5. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.

- 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results.
 - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour 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.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. 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.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Slump Flow: ASTM C1611/C1611M:
 - a. 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.
 - b. Perform additional tests when concrete consistency appears to change.
 4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.

- a. 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 C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. 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 C31/C31M:
 - a. Cast and laboratory cure two sets of four 6-inch (150 mm) by 12-inch (300 mm) or 4-inch (100 mm) by 8-inch (200 mm) cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure two sets of four standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of three laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. Test one set of three field-cured specimens at seven days and one set of two specimens at 28 days.
 - c. 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. 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) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
11. 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.
12. Additional Tests:
 - a. 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.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

- 1) Acceptance criteria for concrete strength shall be in accordance with **ACI 301 (ACI 301M)**, section 1.6.6.3.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with **ASTM E1155 (ASTM E1155M)** within 72 hours of completion of floor finishing and promptly report test results to Architect.

3.12 PROTECTION

- A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
 2. Diaper hydraulic equipment used over concrete surfaces.
 3. Prohibit vehicles from interior concrete slabs.
 4. Prohibit use of pipe-cutting machinery over concrete surfaces.
 5. Prohibit placement of steel items on concrete surfaces.
 6. Prohibit use of acids or acidic detergents over concrete surfaces.
 7. 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.
 8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete masonry units.
 - 2. Steel reinforcing bars.

1.2 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of product. For masonry units, include material test reports substantiating compliance with requirements.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 - 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.5 FIELD CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. Integral Water Repellent: Provide units made with integral water repellent.
- C. CMUs: ASTM C90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2150 psi (14.8 MPa)**.
 - 2. Density Classification: Lightweight.

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.

- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- F. Aggregate for Mortar: ASTM C144.
 - 1. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C404.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
- J. Water: Potable.

2.4 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60** (Grade 420).
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch (3.77-mm)** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.

2.5 MISCELLANEOUS MASONRY ACCESSORIES

- A. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.6 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. For masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type S.
 - 3. For mortar parge coats, use Type S.
- D. Grout for Unit Masonry: Comply with ASTM C476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
 - 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.

3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**, with a maximum thickness limited to **1/2 inch (12 mm)**.
2. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (9 mm)** or minus **1/4 inch (6 mm)**.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- F. Fill cores in hollow CMUs with grout **24 inches (600 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (150 mm)**.
 - 1. Space reinforcement not more than **16 inches (406 mm)** o.c.
 - 2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

3.6 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than **60 inches (1520 mm)**.

3.7 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level [B] [C] in TMS 402/ACI 530/ASCE 5.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.
- I. Prism Test: For each type of construction provided, according to ASTM C1314 at 28 days.

3.8 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.9 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
 - 2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.10 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Do not dispose of masonry waste as fill within **18 inches (450 mm)** of finished grade.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Product certificates.

- C. Product test reports.

- D. Evaluation Reports: For 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. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

- B. Product Tests: Mill certificates or data from a qualified independent testing agency.

- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
 - 1. Wall Studs: AISI S211.
 - 2. Headers: AISI S212.
 - 3. Lateral Design: AISI S213.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: **ST33H (ST230H)**, **ST50H (ST340H)** As required by structural performance.
 - 2. Coating: **G60 (Z180)**, **G90 (Z275)** or equivalent.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: **33 (230)**.
 - 2. Coating: **G60 (Z180)**.

2.3 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: **0.0428 inch (1.09 mm)**.
 - 2. Flange Width: **1-3/8 inches (35 mm)**.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and matching minimum base-metal thickness of steel studs.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm) .
2. Flange Width: 1-5/8 inches (41 mm).

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm).
2. Flange Width: 1-3/8 inches (35 mm).

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching minimum base-metal thickness of steel studs.

C. Vertical Deflection Clips: Manufacturer's standard [bypass] [head] clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

- B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel headless, hooked bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by mechanically deposition according to ASTM B695, Class 50.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58, or ICC-ES AC308 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor or adhesive anchor.
 - 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, **1/4 inch (6 mm)** thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch (6 mm)** to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.2 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- E. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- F. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.3 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: As shown on Shop Drawings.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding **1/8 inch (3 mm)** between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 - 1. Stud Spacing: **16 inches (406 mm)**.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically **48 inches (1220 mm)**. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to **6 inches (150 mm)** deep.

2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
1. Stud Spacing: 16 inches (406 mm).
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to studs and anchor to building structure.
 4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at 96-inch (2440-mm) centers.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Steel framing and supports for countertops.
- 2. Steel framing and supports for mechanical and electrical equipment.
- 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
- 4. Metal ladders.
- 5. Metal ships' ladders.
- 6. Metal floor plate and supports.
- 7. Miscellaneous steel trim.
- 8. Metal downspout boots.
- 9. Loose bearing and leveling plates for applications where they are not specified in other Sections.

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

- 1. Loose steel lintels.
- 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

- C. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Prefabricated building columns.
3. Metal nosings and treads.
4. Paint products.
5. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for countertops.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Metal ladders.
5. Metal ships' ladders.
6. Metal floor plate and supports.
7. Miscellaneous steel trim.
8. Metal downspout boots.
9. Loose steel lintels.

C. Delegated-Design Submittal: For ladders and ships' ladders including analysis data signed and sealed by the qualified professional engineer, registered in the State of Maryland. responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, registered in the State of Maryland and as defined in Section 014000 "Quality Requirements," to design ladders.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- F. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- G. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallicly bonded to steel.
- H. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- I. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Zinc-Coated Steel Wire Rope: ASTM A 741.
 - 1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- K. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm).
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating; 0.064-inch (1.6-mm) nominal thickness.
 - 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, 0.0528-inch (1.35-mm) minimum thickness; hot-dip galvanized after fabrication.
- L. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- M. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6)**; with hex nuts, **ASTM A 563 (ASTM A 563M)**; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**; with hex nuts, **ASTM F 594 (ASTM F 836M)**; and, where indicated, flat washers; Alloy Group **1 (A1)**.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, **ASTM A 563 (ASTM A 563M)**; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group **1 (A1)** stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)**.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.

- C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Galvanize miscellaneous framing and supports where indicated.
- E. Prime miscellaneous framing, including galvanized materials, and supports.

2.7 METAL LADDERS

A. General:

- 1. Comply with ANSI A14.3.
- 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

- 1. Space siderails 16 inches (406 mm) apart unless otherwise indicated.
- 2. Siderails: Continuous, 1/2-by-2-1/2-inch (12.7-by-64-mm) steel flat bars, with eased edges.
- 3. Rungs: 3/4-inch- (19-mm-) diameter steel bars.
- 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
- 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
- 6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
- 7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
- 8. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
- 9. Galvanize and prime ladders, including brackets.
- 10. Prime with primer specified in Section 099600 "High-Performance Coatings."

2.8 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

- 1. Treads shall be not less than 5 inches (127 mm) exclusive of nosing or less than 8-1/2 inches (216 mm) including the nosing, and riser height shall be not more than 9-1/2 inches (241 mm).
- 2. Fabricate ships' ladders and pipe crossovers, including railings from steel stainless steel, aluminum.
- 3. Fabricate treads from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch (12 mm) in least dimension.
- 4. Fabricate treads from rolled-steel floor plate.
- 5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."
- 6. Prime steel ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners with primer specified in Section 099600 "High-Performance Coatings."

2.9 METAL DOWNSPOUT BOOTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. J.R. Hoe & Sons Inc.
 - 2. Neenah Foundry Company.
- B. Source Limitations: Obtain downspout boots from single source from single manufacturer.
- C. 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.
- D. Prime cast-iron downspout boots with primer specified in Section 099600 "High-Performance Coatings."

2.10 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 and prime miscellaneous steel trim.

2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize and prime plates.

2.12 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than **8 inches (200 mm)** unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls, with primer specified in Section 099600 "High-Performance Coatings."

2.13 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" unless primers specified in Section 099600 "High-Performance Coatings" are indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.

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 operable partitions, overhead doors, and overhead grilles securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off

flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel pipe railings.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer, licensed in the State of Maryland, responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.

- C. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the State of Maryland and as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces).

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL AND IRON

- A. Tubing: ASTM A500 (cold formed) or ASTM A513.
- B. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5 for zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 2. Provide flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
 - 1. Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form Changes in Direction as Follows:
 - 1. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

- K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
 - 2. Basis-of-Design Bracket at Platform rails: Blum #376.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- P. For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
 - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 STEEL AND IRON FINISHES

- A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." requirements indicated below:]
 - 1. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Railings Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 4. Other Railings: SSPC-SP 3, "Power Tool Cleaning."
- C. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with primers specified in Section 099600 "High-Performance Coatings".
 2. Do not apply primer to galvanized surfaces.
- D. Shop-Painted Finish: Comply with Section 099600 "High-Performance Coatings."
1. Color: As selected by Architect from manufacturer's full range.
- E. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches (50 mm)** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

- A. 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, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed with **1/8-inch (3-mm)** buildup, sloped away from post.
- C. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
- B. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.
 - 3. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.

3.6 ADJUSTING AND CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

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. Wood blocking and nailers.
 - 2. Plywood backing panels.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Preservative-treated wood.
 - 2. Fire-retardant-treated wood.
 - 3. Power-driven fasteners.
 - 4. Post-installed anchors.

5. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Forest Certification: Provide wood products made from forests certified by an FSC-accredited certification body.
- B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.
2. Roof blocking.
3. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
4. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.
3. Equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.

B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.

C. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades:

1. Mixed southern pine or southern pine, No. 3 grade; SPIB.
2. Eastern softwoods, No. 3 Common grade; NELMA.
3. Northern species, No. 3 Common grade; NLGA.
4. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than **3/4-inch (19-mm)** nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Screws for Fastening to Metal Framing: For fastening to non-load-bearing framing: ASTM C 1002, and for fastening to cold-formed metal framing ASTM C 954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193, or ICC-ES AC308 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.7 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 1. Use inorganic boron for items that are continuously protected from liquid water.
 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

- J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

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

END OF SECTION 061053

SECTION 066401 – FIBERGLASS REINFORCED PLASTIC PANELING

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. Factory-laminated plastic sheet paneling.

B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for wood furring for installing plastic paneling.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.4 QUALITY ASSURANCE

- A. Testing Agency: Acceptable to authorities having jurisdiction.

1.5 PROJECT 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 FACTORY-LAMINATED PLASTIC SHEET PANELING

- A. Factory-Laminated Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319, laminated to water-resistant gypsum board. Panels shall be USDA accepted for incidental food contact.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Citadel Architectural Products, Inc.](#)
 - b. [Crane Composites, Inc.](#)
 - c. [Nudo Products, Inc.](#)
 2. 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 or less.
 - b. Smoke-Developed Index: 450 or less.
 3. Glass-Fiber-Reinforced Plastic Panel Nominal Thickness: Not less than 0.075 inch (1.9 mm).
 4. Surface Finish: As selected by Architect from manufacturer's full range.
 5. Color: As selected by Architect from manufacturer's full range.
 6. Water-Resistant Gypsum Board: ASTM C1396/C1396M or ASTM C1178/C1178M, **5/8 inch (15.9 mm)**, Type X, with water-resistant core and surfaces.

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: Sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "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.
- 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 factory-laminated panels using concealed mounting splines in panel joints.
- E. Install trim accessories with adhesive. Do not fasten through panels.
- F. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.

- G. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- H. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- I. 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 066400

SECTION 071800 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes traffic coatings and pavement markings for the following applications:
 - 1. Pedestrian traffic.
 - 2. Vehicular traffic.
 - 3. Equipment-room floor.

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 installation instructions and details, material descriptions, dry or wet film thickness requirements, and finish.
- B. Shop Drawings: For traffic coatings.
 - 1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions that are not included in manufacturer's product data.
 - 2. Include plans showing layout of pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples for Initial Selection: For each type of exposed finish.
- D. Samples for Verification: For each type of exposed finish, prepared on rigid backing.
 - 1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Certificates: For each type of traffic coating.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build mockup for each traffic coating and substrate to receive traffic coatings.
 - 2. Size: 200 sq. ft. (18.5 sq. m) of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F (5 deg C), when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
 - 1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
- B. Do not install traffic coating until items that penetrate membrane have been installed.
- C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Adhesive or cohesive failures.
 - b. Abrasion or tearing failures.
 - c. Surface crazing or spalling.
 - d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations:

1. Obtain traffic coatings from single source from single manufacturer.
2. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.
3. Obtain pavement-marking paint from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- #### A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 TRAFFIC COATING

- #### A. Traffic Coating: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for pedestrian traffic, vehicular traffic, and equipment-room floor service condition; according to ASTM C957/C957M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Slide-Lok.
 - b. BASF Corporation.
 - c. Pecora Corporation.
 - d. PPG Paints.
 - e. Sherwin-Williams Company (The).
 - f. Urethane Polymers International, Inc.

- B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.
 - 1. Material: Polyurethane.
- C. Preparatory and Base Coats: Polyurethane.
 - 1. Thicknesses: Minimum dry or wet film thickness as recommended in writing by manufacturer for substrate and service conditions indicated.
- D. Intermediate Coat: Polyurethane.
 - 1. Thicknesses: Minimum dry or wet film thickness as recommended in writing by manufacturer for substrate and service conditions indicated, measured excluding aggregate.
 - 2. Aggregate Content: As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated.
- E. Topcoat: Polyurethane.
 - 1. Thicknesses: Minimum dry or wet film thickness as recommended in writing by manufacturer for substrate and service conditions indicated, measured excluding aggregate.
 - 2. Aggregate Content: As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated.
 - 3. Color: As selected by Architect from manufacturer's full range.
- F. Aggregate: Manufacturer's standard aggregate for each use indicated of particle sizes, shape, and minimum hardness recommended in writing by traffic-coating manufacturer.
- G. Fire-Test-Response Characteristics: Provide traffic-coating materials with the fire-test-response characteristics as determined by testing identical products according to approved test methods for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.

2.4 ACCESSORY MATERIALS

- A. Joint Sealants: As specified in Section 079200 "Joint Sealants." And ASTM C920.
- B. Sheet Flashing: Nonstaining sheet material recommended in writing by traffic-coating manufacturer.
 - 1. Thickness: Minimum 60 mils (1.5 mm).
- C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.
- D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

2.5 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
 - 1. Color: Yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.
- B. Verify that substrates are visibly dry and free of moisture.
 - 1. Test for moisture according to ASTM D4263.
 - 2. Test for moisture content by method recommended in writing by traffic-coating manufacturer.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after substrate construction and penetrating work have been completed.
 - 2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
 - 3. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Clean and prepare substrates according to ASTM C1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.
- B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.
 - 1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.
- C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.

- D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.
- E. Concrete Substrates: Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D4259. Do not acid etch.
 - 1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 - 2. Remove concrete fins, ridges, and other projections.
 - 3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
 - 4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D4258.

3.3 TERMINATIONS AND PENETRATIONS

- A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C1127 and manufacturer's written instructions.
- B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
- C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
- D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.4 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.
 - 1. Comply with recommendations in ASTM C1193 for joint-sealant installation.
- B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.5 TRAFFIC-COATING APPLICATION

- A. Apply traffic coating according to ASTM C1127 and manufacturer's written instructions.
- B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.
- C. Start traffic-coating application in presence of manufacturer's technical representative.

- D. Verify that wet-film thickness of each coat complies with requirements every 100 sq. ft. (9 sq. m).
- E. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.
- F. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.
- G. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.6 PAVEMENT MARKINGS

- A. Do not apply pavement-marking paint for striping and other markings until layout, colors, and placement have been verified with Architect and traffic coating has cured.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply pavement-marking paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges. Apply at manufacturer's recommended rates for a minimum wet-film thickness of **15-mils (0.4-mm)**.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
 - 2. Broadcast glass beads uniformly into wet pavement-marking paint at a rate of **6 lb/gal. (0.72 kg/L)**.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform the following field tests and inspections:
 - 1. Materials Testing:
 - a. Samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of Contractor.
 - b. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures.
 - c. Testing agency shall verify thickness of coatings during traffic-coating application for each **600 sq. ft. (56 sq. m)** of installed traffic coating or part thereof.
- B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- C. Waterproofing will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.8 PROTECTING AND CLEANING

- A. Protect traffic coatings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071800

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Glass-fiber blanket.
3. Mineral-wool blanket.

B. Related Requirements:

1. Section 133419 "Metal Building Systems" for insulated wall and roof panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings: For roof insulation:

1. Submit manufacturer's shop drawings indicating complete installation details of tapered insulation system, including identification of each insulation block, sequence of installation, layout, drain locations, roof slopes, thicknesses, crickets, and saddles.
2. Shop drawings shall include: Outline of roof, locations of drains, complete board layout of tapered insulation components, thicknesses, and the average R value for the completed insulation system.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

- C. Certificates: For roof insulation and associated products.

1. Letter from insulation manufacturer approving use of insulation, fasteners, and accessories within roofing system.
2. Letter from roofing manufacturer approving use of insulation, coverboard, fasteners, and accessories as component of roofing system, including warranty requirements.
3. Certification that insulation and fastening system furnished is tested and approved by Factory Mutual for 1-90 Wind Up-Lift Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

- A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.
- B. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, **25-psi (173-kPa)** minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dow Chemical Company (The).
 - 2. Owens Corning.
 - 3. Pactiv Building Products.

2.2 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 - 1. Locations: Sound batt insulation.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville; a Berkshire Hathaway company.
 - 3. Knauf Insulation.
 - 4. Owens Corning.

2.3 MINERAL-WOOL BLANKETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [Roxul Inc.](#)
 2. [Thermafiber, Inc.; an Owens Corning company.](#)
- B. Mineral-Wool Blanket, Unfaced: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
1. Locations: Sound attenuating fire batt (SAFB) insulation, and exterior ceilings and soffits.

2.4 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation (not in roofs): Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.7 BATT INSULATION SCHEDULE

- A. Provide batts sized to match stud construction, unless otherwise indicated, with R-values as follows:
 1. Vertical 3-5/8" Stud: R-13 minimum.
 2. Vertical 6" Stud: R-20 minimum.

3. Horizontal Applications: R-49 minimum.

END OF SECTION 072100

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Formed wall sheet metal fabrications.
- 2. Formed equipment support flashing.

B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
- 2. Section 133419 "Metal Building Systems" for sheet metal flashing and trim integral with metal wall panels.

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
 - 3. Review requirements for insurance and certificates if applicable.
 - 4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
 - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
 - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
 - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 6. Include details of termination points and assemblies.
 - 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 - 8. Include details of roof-penetration flashing.
 - 9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 10. Include details of special conditions.
 - 11. Include details of connections to adjoining work.
 - 12. Detail formed flashing and trim at scale of not less than **1-1/2 inches per 12 inches (1:10)**.
- C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- D. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: **12 inches (300 mm)** long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: **12 inches (300 mm)** long and in required profile. Include fasteners and other exposed accessories.
 - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is SPRI ES-1 tested and FM Approvals approved.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For copings and roof edge flashings that are SPRI ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. FM Approvals Listing: Manufacture and install copings and roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with name of fabricator and design approved by FM Approvals.
- D. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color: Match metal roof color.
 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).
- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; with smooth, flat surface.
 1. Finish: 2D (dull, cold rolled).

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Self-Adhering, High-Temperature Sheet: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt

adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Carlisle Coatings & Waterproofing Inc.](#); CCW WIP 300HT.
 - b. [Henry Company](#); Blueskin PE200 HT.
 - c. [Owens Corning](#); WeatherLock Metal High Temperature Underlayment.
 2. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
 3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C) or lower.
- C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
 4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
- C. Solder:
1. For Stainless Steel: ASTM B 32, Grade Sn96, with acid flux of type recommended by stainless-steel sheet manufacturer.
 2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, with maximum lead content of 0.2 percent.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 2. Obtain field measurements for accurate fit before shop fabrication.
 - 3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 feet (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
- H. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

- I. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- J. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum **96-inch- (2400-mm-)** long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
 - 1. Gutter Profile: Style B according to cited sheet metal standard.
 - 2. Expansion Joints: Butt type with cover plate.
 - 3. Accessories: Wire-ball downspout strainer and valley baffles.
 - 4. Gutters with Girth **21 to 25 Inches (530 to 640 mm)**: Fabricate from the following materials:
 - a. Aluminum: **0.050 inch (1.27 mm)** thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
 - 1. Fabricated Hanger Style: Fig 1-35B according to SMACNA's "Architectural Sheet Metal Manual."
 - 2. Fabricate from the following materials:
 - a. Aluminum: **0.024 inch (0.61 mm)** thick.
- C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
 - 1. Aluminum: **0.050 inch (1.27 mm)** thick.
- D. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
 - 1. Aluminum: **0.040 inch (1.02 mm)** thick.
 - 2. Stainless Steel: **0.019 inch (0.48 mm)** thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12-foot- (3.6-m-)** long sections. Furnish with **6-inch- (150-mm-)** wide, joint cover plates. Shop fabricate interior and exterior corners.
 - 1. Joint Style: Butted with expansion space and **6-inch- (150-mm-)** wide, concealed backup plate.
 - 2. Fabricate from the Following Materials:

- a. Aluminum: 0.050 inch (1.27 mm) thick.
 - B. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.
 - 1. Coping Profile: Fig 3-4A according to SMACNA's "Architectural Sheet Metal Manual."
 - 2. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate.
 - 3. Fabricate from the Following Materials:
 - a. Aluminum: 0.050 inch (1.27 mm) thick.
 - C. Base Flashing: Fabricate from the following materials:
 - 1. Aluminum: 0.040 inch (1.02 mm) thick.
 - D. Counterflashing: Fabricate from the following materials:
 - 1. Aluminum: 0.032 inch (0.81 mm) thick.
 - E. Flashing Receivers: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
 - F. Roof-Penetration Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch (0.48 mm) thick.
 - G. Roof-Drain Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
- 2.8 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS
- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
 - 2. Galvanized Steel: 0.022 inch (0.56 mm) thick.
 - B. Drip Edges: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
 - 2. Galvanized Steel: 0.022 inch (0.56 mm) thick.
 - C. Counterflashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch (0.48 mm) thick.
 - 2. Galvanized Steel: 0.022 inch (0.56 mm) thick.
 - D. Flashing Receivers: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.

2.9 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings; and form with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
- B. Opening Flashings in Frame Construction: Fabricate head, jamb, sill, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch (0.40 mm) thick.
- C. Wall Expansion-Joint Cover: Fabricate from the following materials:
 - 1. Aluminum: 0.040 inch (1.02 mm) thick.
 - 2. Stainless Steel: 0.019 inch (0.48 mm) thick.

2.10 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch (0.48 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

- C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller. Cover underlayment within 14 days.
- D. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Run continuous cleats attached not more than 6 inches (150 mm) on center. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Torch cutting of sheet metal flashing and trim is not permitted.
 - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws substrate, or not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder aluminum sheet.
 2. Do not use torches for soldering.
 3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
 4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints or joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Fasten gutter spacers to front and back of gutter.
 2. Anchor and loosely lock back edge of gutter to continuous cleat.
 3. Anchor gutter with gutter brackets spaced not more than **36 inches (910 mm)** apart to roof deck, unless otherwise indicated, and loosely lock to front gutter bead.
 4. Install gutter with expansion joints at locations indicated, but not exceeding, **50 feet (15.24 m)** apart. Install expansion-joint caps.
- C. Downspouts: Join sections with **1-1/2-inch (38-mm)** telescoping joints.
1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately **60 inches (1500 mm)** o.c.
 1. Connect downspouts to underground drainage system, unless otherwise indicated.
 2. Provide elbows at base of downspout to direct water away from building, where indicated.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement or elastomeric sealant compatible with the substrate.
- E. Parapet Scuppers: Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
1. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.

- F. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches (100 mm) in direction of water flow.

3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
- C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- D. Copings: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.
- E. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- F. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm). Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.
- G. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Through-Wall Flashing: Installation of through-wall flashing is specified in Section 042000 "Unit Masonry."
- C. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.7 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.8 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 feet (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.9 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 077253 - SNOW GUARDS

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. Rail-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
 - 1. Include details of rail-type snow guards.
- C. Samples:
 - 1. Rail-Type Snow Guards: Bracket, 12-inch- (300-mm-) long rail, and installation hardware.
 - a. For units with factory-applied finishes, submit color matching metal roof selection.
- D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include calculation of number and location of snow guards.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction in which the Project is located.
- B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.5 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

- B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

- C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: 26.5 psf.

2.2 RAIL-TYPE SNOW GUARDS

- A. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
 - b. Berger Building Products, Inc.
 - c. IceBlox Inc.

- d. LMCurbs.
 - e. PMC Industries, Ltd.
 - f. Rocky Mountain Snow Guards, Inc.
 - g. S-5! Attachment Solutions; Metal Roof Innovations, Ltd.
 - h. TRA Snow and Sun, Inc.
2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with three rails with integral track to accept color-matching inserts of material and finish used for metal roof.
 3. Brackets and Baseplate: ASTM A240/A240M, Type 304 stainless steel; mill.
 4. Bars: ASTM B221 (ASTM B221M) aluminum; Kynar 500/ hylar 5000 color to match metal roof panels.
 - a. Profile: Round, or Square with integral track to accept color-matching inserts of material and finish used for metal roof.
 5. Seam clamps: ASTM B221 (ASTM B221M) aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates for bonding snow guards.
- B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions.
 1. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Rail-Type, Seam-Mounted Snow Guards:
 - a. Install brackets to vertical ribs in straight rows.
 - b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
 - c. Torque set screw according to manufacturer's instructions.
 - d. Install cross members to brackets.

END OF SECTION 077253

SECTION 078413 FIRE PROTECTION, HVAC & PLUMBING PENETRATION FIRESTOPPING

PART 1. GENERAL

1.1. SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section includes:
 - 1. Through-penetration firestopping in fire rated construction.
 - 2. Through-penetration smoke-stopping in smoke partitions.
- C. Related items:
 - 1. Fire dampers and manufactured devices: Refer to Division 23 Section HVAC Air Distribution.
 - 2. Smoke dampers and combination fire/smoke dampers. Refer to Division 23 Section HVAC Air Distribution.

1.2. REFERENCES

- A. Underwriters Laboratories
 - 1. UL Fire Resistance Directory
 - a. Through-penetration firestop devices (XHCR)
 - b. Fire resistance rating (BXUV)
 - c. Through-penetration firestop systems (XHEZ)
 - d. Fill, void, or cavity material (XHHW)
- B. American Society for Testing and Materials Standards:
- C. ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.3. DEFINITIONS

- A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
- B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.
- C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.
- D. Penetration: Opening or foreign material passing through or into barrier or structural floor

such that full thickness of rated materials is not obtained.

- E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
- F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.4. SYSTEM DESCRIPTION

A. Design Requirements

- 1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations.
- 2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.5. SUBMITTALS

- A. Submit in accordance with Division 01 Section Submittal Procedures, unless otherwise indicated.
- B. Product data: Manufacturer's specifications and technical data including the following:
 - 1. Detailed specification of construction and fabrication.
 - 2. Manufacturer's installation instructions.
- C. Shop drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.
 - 1. Details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
 - 2. Manufacturer or manufacturer's representative shall provide qualified engineering judgment and drawings relating to non-standard applications as needed.
- D. Quality control submittals:
 - 1. Statement of qualifications.
- E. Applicators' qualifications statement:
 - 1. List past projects indicating required experience.

1.6. QUALITY ASSURANCE

- A. Installer's qualifications: Fire experienced in installation or application of systems similar

in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
 2. At least 2 years experience with systems.
 3. Successfully completed at least 5 comparable scale projects using this system.
- B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.
- C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping:
1. Deliver products in original unopened packaging with legible manufacturer's identification.
 2. Coordinate delivery with scheduled installation date, allow minimum storage at site.
- B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.8. PROJECT CONDITIONS

- A. Existing condition:
1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
 2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.
- B. Environmental requirements:
1. Furnish adequate ventilation if using solvent.
 2. Furnish forced air ventilation during installation if required by manufacturer.
 3. Keep flammable materials away from sparks or flame.
 4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by

firestopping materials.

1.9. WARRANTY

- A. Submit copies of written warranty agreeing to repair or replace joint sealers which fail in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The warranty period shall be two (2) years from date of substantial completion unless otherwise noted.

PART 2. PRODUCTS

2.1. THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

- A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.
 - 1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.
 - 2. Acceptable manufacturers and products.
 - a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the System and Applications Schedule in Part 3.6 of this section.
 - 3. All firestopping products must be from a single manufacturer. All trades shall use products from the same manufacturer unless otherwise noted.

2.2. SMOKE-STOPPING AT SMOKE PARTITIONS

- A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in The Systems and Applications Schedule in Part 3.6 of this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.3. ACCESSORIES

- A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.
- B. Forming materials: As classified under category XHKU in the UL Fire Resistance

Directory.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - 1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.
- B. Coordinate an inspection of all Mechanical Firestopping systems with the Fire Marshal prior to installation of ceilings, walls, etc.

3.2. PREPARATION

- A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3. INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.
- C. Protect materials from damage on surfaces subject to traffic.
- D. When large openings are created in walls or floors to permit installation of pipes, ducts, or other items, close unused portions of opening with firestopping materials tested for the application. See UL Fire Resistance Directory or Section 3.6 of this document.
 - 1. Install smoke stopping as specified for firestopping.

3.4. FIELD QUALITY CONTROL

- A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Perform under this section patching and repairing of firestopping caused by cutting or

penetration by other trades.

- D. ADJUSTING AND CLEANING
- E. Clean up spills of liquid components.
- F. Neatly cut and trim materials as required.
- G. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.5. SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP25WB+ WJ1023 2001	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195 CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195 FC2026 FS-195+ FC2028 FS-195, 1' & 2-inch WIDE, PPD'S
Insulated Metallic Pipe	CAJ5001 CP 25N/S, CP 25S/L, CP 25WB+ CAJ5002 FS-195+ CAJ5003 FS-195+ CAJ5005 MPS-2+ CAJ5009 2000+, 2003 CAJ5017 FS-195+, CP 25 CAJ5022 FS-195+ CAJ5024 FS-195+ CAJ5030 CS-195+, FS-195+ CAJ5041 2000, 2000+, 2003 CAJ5060 CP 25WB+ CAJ5074 2000+ CBJ5002 CP 25 CBJ5003 FS-195+ FA5001 FS-195+, CP 25WB+	WL5001 FS-195+ WL5002 FS-195+ WL5009 FS-195+ WL5010 FS-195+ WL5011 CP 25WB+ WL5032 2000+ WL5038 CP 25WB+ WL5039 CP 25WB+ WL5040 CP 25WB+ WL5045 CP 25WB+ WL5053 2000+	FC5002 FS-195+ FC5008 FS-195+
Miscellaneous Mechanical HVAC Ducts	CAJ7001 CP 25N/S CP 25S/L CAJ7003 CP 25WB+ CAJ7009 DUCT WRAP, BULK PUTTY		FC7001 CP 25S/L, CP 25N/S
Mixed Penetrating Items Combos	CAJ8001 CS-195+ FS-195 CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001 FA8001 FS-195+, CP 25WB+	WL8002 CS-195+, FS-195+	

*Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Mildew-resistant joint sealants.
5. Butyl joint sealants.
6. Latex joint sealants.

B. Related Requirements:

1. Section 0951113 "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in ~~1/2-inch-~~ (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.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

- B. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- D. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- E. Field-Adhesion-Test Reports: For each sealant application tested.
- F. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 - 3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with stone and masonry substrates.
 - 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.

5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Interior wet-applied sealants and sealant primers: Comply with low-emitting requirements in Division 01 Section "Sustainable Design Requirements - LEED."
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant: ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 1. Interior wet-applied primer: Comply with low-emitting requirements in Division 01 Section "Sustainable Design Requirements - LEED."
 2. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation](#).
 - b. [Pecora Corporation](#); 860.
 - c. [Sika Corporation; Joint Sealants](#); Sikasil-GP.

2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation](#); Dow Corning® 795 Silicone Building Sealant.

- b. [Pecora Corporation](#); 864NST.
- c. [Sika Corporation; Joint Sealants](#); Sikasil WS-295.
- d. [Tremco Incorporated](#); Spectrem 3.

2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Pecora Corporation](#); Dynatrol I-XL.
 - b. [Polymeric Systems, Inc.](#); Flexiprene 1000.
 - c. [Sika Corporation; Joint Sealants](#); Sikaflex Textured Sealant.
 - d. [Tremco Incorporated](#); Dymonic.
- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [BASF Corporation; Construction Systems](#); MasterSeal SL 1 (Pre-2014: Sonolastic SL1).
 - b. [Pecora Corporation](#); NR-201.
 - c. [Polymeric Systems, Inc.](#); Flexiprene 952.
 - d. [Sherwin-Williams Company \(The\)](#); Stampede 1SL.
- C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; DynaTrol II.
 - b. Tremco Incorporated; Vulkhem 445SSL.

2.5 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation](#); DOW CORNING® 786 SILICONE SEALANT -.
 - b. [GE Construction Sealants; Momentive Performance Materials Inc.](#); SCS1700 Sanitary.
 - c. Pecora Corporation; 898NST.
 - d. [Tremco Incorporated](#); Tremsil 200.

2.6 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.

2.7 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20.
 - b. Sherwin-Williams Company (The); 950A Siliconized Acrylic Latex Caulk, White.
 - c. Tremco Incorporated; Tremflex 834.

2.8 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Cast Stone Masonry.
 - d. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 - 4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.

- b. Joints between plant-precast architectural concrete paving units.
 - c. Joints between sidewalks and building.
 - d. Joints between different materials listed above.
 - e. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.
 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units.
 - c. Control and expansion joints in unit masonry.
 - d. Joints in dimension stone cladding.
 - e. Joints in glass unit masonry assemblies.
 - f. Joints between metal panels.
 - g. Joints between different materials listed above.
 - h. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - i. Control and expansion joints in ceilings and other overhead surfaces.
 - j. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring (other than ceramic tile).
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, P, 25, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.
 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Vertical joints on exposed surfaces of unit masonry walls and partitions.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
 1. Joint Locations:
 - a. Perimeter joints between interior wall surfaces and frames of interior doors and windows.

- b. Drywall inside corners.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Acrylic latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Concealed mastics.
 - 1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Butyl-rubber based.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 079513.13 - 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.
- B. Related Requirements:
 - 1. Section 079200 "Joint Seals."

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 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.
- D. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Furnish units in longest practicable lengths to minimize field splicing.
- B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

- C. Manufacturers: Subject to compliance with requirements, provide basis-of-design product by MM Systems Corporation, or comparable product by one of the following:

1. Construction Specialties, Inc.
2. Inpro Corporation.

2.2 PERFORMANCE REQUIREMENTS

- A. Expansion Joint Design Criteria:

1. Type of Movement
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.

2.3 WALL EXPANSION JOINT COVERS

- A. Metal-Plate Wall Joint Cover (**EJ-1**): Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Basis-of-Design: MM Systems EX-L2
2. Application: Wall to corner.
3. Fire-Resistance Rating: Not less than that indicated on Drawings.
4. Exposed Metal:
 - a. Aluminum: Clear anodic, Class II.

2.4 MATERIALS

- A. Aluminum: **ASTM B 221 (ASTM B 221M)**, Alloy 6063-T5 for extrusions; **ASTM B 209 (ASTM B 209M)**, Alloy 6061-T6 for sheet and plate.
1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304 for plates, sheet, and strips.
- C. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
- D. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.
- E. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.5 ALUMINUM FINISHES

- A. Mill finish.

- B. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.6 ACCESSORIES

- A. Manufacturer's standard attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.
 - 1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
 - 2. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 - 3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
 - 5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

- C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
 - 1. Provide in continuous lengths for straight sections.
 - 2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 - 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 079513.13

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
3. Division 08 Section "Door Hardware".
4. Division 08 Section "Access Control Hardware".
5. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.

11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of anchorages, joints, field splices, and connections.
 6. Details of accessories.
 7. Details of moldings, removable stops, and glazing.
 8. Details of conduit and preparations for power, signal, and control systems.
- D. Samples for Verification:
 1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.

1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate installation of anchorages 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.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
 - 1. CECO Door Products (C).
 - 2. Curries Company (CU).
 - 3. Pioneer Industries (PI).
 - 4. Steelcraft (S).

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Design: Flush panel.
 - 2. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
 - 3. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw

attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.

4. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
5. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel.
 - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
2. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
3. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
4. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
5. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

1. Curries Company (CU) - Polystyrene Core - 707 Series.
2. Curries Company (CU) - Energy Efficient - 797 Mercury Series.

2.4 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.

C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
3. Manufacturers Basis of Design:
 - a. Curries Company (CU) – Thermal Break TQ Series.

- D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
 2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
 3. Manufacturers Basis of Design:
 - a. Curries Company (CU) - CM Series.
 - b. Curries Company (CU) - M Series.
- E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
 3. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for

use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.7 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.8 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
 - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
 - 3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
 - 4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
- D. Hollow Metal Frames:
 - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
 - 3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - 4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.

5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
 6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
 7. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
 8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 9. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
 10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.9 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
 - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and

- secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jamb and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid core doors with wood veneer faces.
2. Factory finishing wood doors.
3. Factory fitting wood doors to frames and factory machining for hardware.
4. Louvers installed in flush wood doors.
5. Light frames and glazing installed in wood doors.

B. Related Sections:

1. Division 08 Section "Door Schedule".
2. Division 08 Section "Hollow Metal Doors and Frames".
3. Division 08 Section "Glazing".
4. Division 08 Section "Door Hardware".
5. Division 28 Section "Access Control".

C. Standards and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. Intertek Testing Service (ITS Warnock Hersey) - Certification Listings for Fire Doors.
3. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
4. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
5. UL 10C - Positive Pressure Fire Tests of Door Assemblies; UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
6. Window and Door Manufacturers Association - WDMA I.S.1-A Architectural Wood Flush Doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, trim for openings, and WDMA I.S.1-A classifications. Include factory finishing specifications.

B. Shop Drawings shall include:

1. Indicate location, size, and hand of each door.
2. Indicate dimensions and locations of mortises and holes for hardware.
3. Indicate dimensions and locations of cutouts.
4. Indicate requirements for veneer matching.
5. Indicate location and extent of hardware blocking.

6. Indicate construction details not covered in Product Data.
7. Indicate doors to be factory finished and finish requirements.
8. Indicate fire protection ratings for fire rated doors.

C. Samples for Initial Selection: For factory finished doors.

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
2. Corner sections of doors, 8 by 10 inches, with door faces and edges representing actual materials to be used.
 - a. Provide samples for each species of veneer and core material.
 - b. Finish veneer faced door samples with same materials proposed for factory finished doors.
3. Frames for light openings, 6 inches long, for each material, type, and finish required.

D. Warranty: Provide sample of manufacturer's warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, latest edition, "Industry Standard for Architectural Wood Flush Doors".
- C. Fire Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL10C.
 1. Oversize Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies provide manufacturer's construction label, indicating compliance to independent 3rd party certification agency's procedure, except for size.
 2. Temperature Rise Limit: Where required and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire test exposure.
 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - 1) Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for receiving, handling, and installing flush wood doors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.

- B. Package pre-finished doors individually in plastic bags and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in wood face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 DOOR CONSTRUCTION – GENERAL

- A. WDMA I.S.1-A Performance Grade: Extra Heavy Duty; Aesthetic Grade: Premium.
- B. Fire Rated Doors: Provide construction and core as needed to provide fire ratings indicated.
 - 1. Category A Edge Construction: Provide fire rated door edge construction with intumescent seals concealed by outer stile (Category A) at 45, 60, and 90 minute rated doors. Comply with specified requirements for exposed edges.
 - 2. Pairs: Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - a. Provide fire retardant stiles that are listed and labeled for applications indicated without formed steel edges and astragals.
- C. Environmentally Responsible Doors: Provide doors constructed with the following environmentally responsible characteristics:
 - 1. Recycled Content: Provide composite wood door cores with minimum 80 percent recycled content.

2. Forest Certification: Provide wood products made from forests certified by an FSC-accredited certification body. All non-FSC wood in assemblies with FSC-certified wood shall meet the FSC Controlled Wood (CW) criteria.
3. Composite wood doors: Contain no added formaldehyde resins and comply with the California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM) for formaldehyde emissions for ultra-low-emitting formaldehyde (ULEF) resins.

2.2 CORE CONSTRUCTION

A. Structural Composite Lumber Core Doors:

1. Structural Composite Lumber: Engineered hardwood composite wood products tested in accordance with WDMA I.S.1A, Testing Cellulosic Composite Materials for Use in Fenestration Products containing no added Urea Formaldehyde.

B. Fire Resistant Composite Core Doors:

1. Core: Non-combustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire protection rating indicated.
2. Blocking: As indicated under article "Blocking".
3. Edge Construction: At hinge stiles, provide laminated edge construction with improved screw holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 BLOCKING

A. Fire Rated Doors:

1. Provide blocking as indicated below:
 - a. HB1: 5 inch in doors indicated to have closers and overhead stops.
 - b. HB4: Two 5 inch x 14 inch lock blocking in doors indicated to have exit devices.

2.4 VENEERED DOORS FOR TRANSPARENT FINISH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASSA ABLOY Wood Doors (GR): GPD Series.
2. Eggers Industries (EG): Premium Series.
3. VT Industries (VT): Artistry Series.

B. Interior Solid Core Doors:

1. Grade: Premium.
2. Faces: Veneer grades as noted below; veneer minimum 1/50-inch (0.5mm) thickness at moisture content of 12% or less.

- a. Cherry, A grade faces.
3. Match between Veneer Leaves: Book match.
4. Assembly of Veneer Leaves on Door Faces:
 - a. Running Match.
5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
6. Transom Match: Continuous match.
7. Vertical Edges: Matching same species as faces. Wood or composite material, one piece, laminated, or veneered. Minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors.
8. Horizontal Edges: Solid wood or structural composite material meeting the minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit sanded before applying face veneers.
10. At doors over 40% of the face cut-out for lights and or louvers, furnish engineered composite lumber core.

2.5 LOUVERS

- A. Metal Louvers: Door manufacturer's standard metal louvers unless otherwise indicated.
 1. Blade Type: Vision proof inverted V or inverted Y.
 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish.

2.6 LIGHT FRAMES AND GLAZING

- A. Wood Beads for Light Openings in Wood Doors up to and including 20-minute rating:
 1. Wood Species: Same species as door faces.
 2. Profile:
 - a. M5 Beveled Lip Bead.
- B. Metal Frames for Light Openings in Fire Rated Doors over 20-minute Rating: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated.
 1. Manufacturers:
 - a. All Metal Stamping (AP).
 - b. Anemostat (AN).
 - c. Pemko (PE).

- C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with the flush wood door manufacturer's written instructions.

2.7 FABRICATION

- A. Factory fit doors to suit frame opening sizes indicated.
 - 1. Comply with requirements in NFPA 80 for fire rated doors.
 - 2. Undercut: As required per manufacturer's templates and sill condition.
- B. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. Metal Astragals: Factory machine astragals and formed steel edges for hardware for pairs of fire rated doors.
- C. Openings: Cut and trim openings through doors in factory.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Comply with applicable requirements in Division 08 Section "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.
- D. Electrical Raceways: Provide flush wood doors receiving electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through wire transfer hardware or wiring harness specified in hardware sets in Division 08 "Door Hardware". Wire nut connections are not acceptable.

2.8 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Transparent Finish: Provide a clear protective coating over the wood veneer allowing the natural color and grain of the selected wood species to provide the appearance specified. Stain is applied to the wood surface underneath the transparent finish to add color and design flexibility.
 - 1. Finish: Meet or exceed WDMA I.S. 1A TR8 UV Cured Acrylated Polyester finish performance requirements.
 - 2. Staining:
 - a. Custom stain to match architect's sample.
 - 3. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 8 Section "Door Hardware."
- B. Installation Instructions: Install doors and frames to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire rated doors in corresponding fire rated frames according to NFPA 80.
- C. Factory Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- E. Field modifications to doors shall not be permitted, except those specifically allowed by manufacturer or fire rating requirements.

3.3 ADJUSTING

- A. Operation: Re-hang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.

Related Requirements:

- 1. Section 233300 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum **6 by 6 inches (150 by 150 mm)** in size.
- C. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acudor Products, Inc.
 - 2. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - 3. Karp Associates, Inc.

4. [Larsens Manufacturing Company.](#)
5. [Milcor; Commercial Products Group of Hart & Cooley, Inc.](#)
6. [Nystrom, Inc.](#)

- B. Source Limitations: Obtain each type of access door and frame from a single source from a single manufacturer.

2.3 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:

1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: 12 inches by 12 inches, minimum.
4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage, factory primed.
 - a. Locations: Interior non-rated masonry assemblies, unless otherwise indicated.
5. Metallic-Coated Steel Sheet for Door: Nominal **0.064 inch (1.63 mm)**, 16 gage, factory primed.
 - a. Locations: Interior side of exterior masonry walls.
6. Stainless-Steel Sheet for Door: Nominal **0.062 inch (1.59 mm)**, 16 gage, No. 4 finish.
 - a. Location: Non-rated masonry assemblies in wet locations, such as toilet rooms, kitchens, and other areas subject to high humidity.
7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Latch bolt, key operated.

B. Flush Access Doors with Concealed Flanges:

1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: 12 inches by 12 inches, minimum.
4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage, factory primed.
5. Metallic-Coated Steel Sheet for Door: Nominal **0.064 inch (1.63 mm)**, 16 gage factory primed.
6. Stainless-Steel Sheet for Door: Nominal **0.062 inch (1.59 mm)**, 16 gage, No. 4 finish.
7. Frame Material: Same material and thickness as door.
8. Latch and Lock: Latch bolt, key operated.

2.4 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Description: Door face flush with frame, uninsulated; with exposed flange, self-closing door, and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: 12 inches by 12 inches, minimum.
4. Fire-Resistance Rating: Not less than that of adjacent construction.
5. Temperature-Rise Rating: **250 deg F (139 deg C)** at the end of 30 minutes.

6. Uncoated Steel Sheet for Door: Nominal **0.036 inch (0.91 mm)**, 20 gage, factory primed.
7. Metallic-Coated Steel Sheet for Door: Nominal **0.040 inch (1.02 mm)**, 20 gage, factory primed.
8. Stainless-Steel Sheet for Door: Nominal **0.038 inch (0.95 mm)**, 20 gage, No. 4 finish.
9. Frame Material: Same material, thickness, and finish as door.
10. Latch and Lock: Self-latching door hardware, operated by key.

B. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Description: Door face flush with frame, uninsulated; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: 12 inches by 12 inches, minimum.
4. Fire-Resistance Rating: Not less than that of adjacent construction.
5. Temperature-Rise Rating: **250 deg F (139 deg C)** at the end of 30 minutes.
6. Uncoated Steel Sheet for Door: Nominal **0.036 inch (0.91 mm)**, 20 gage, factory primed.
7. Metallic-Coated Steel Sheet for Door: Nominal **0.040 inch (1.02 mm)**, 20 gage, factory primed.
8. Stainless-Steel Sheet for Door: Nominal **0.038 inch (0.95 mm)**, 20 gage, No. 4 finish.
9. Frame Material: Same material, thickness, and finish as door.
10. Latch and Lock: Self-closing, self-latching door hardware, operated by key.

2.5 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum **G60 (Z180)** or **A60 (ZF180)** metallic coating.
- D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- E. Frame Anchors: Same material as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.6 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.

2.7 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- E. Stainless-Steel Finishes:
 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 2. Polished Finish: No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

3.4 ACCESS DOOR SCHEDULE

A. Flanges:

1. Flush Access Doors with Exposed Flanges:
 - a. Locations: Masonry substrates.
2. Flush Access Doors with Concealed Flanges:
 - a. Locations: Gypsum board substrates.

B. Materials:

1. Uncoated Steel:
 - a. Locations: Typical use, unless otherwise indicated.
2. Metallic-Coated Steel:
 - a. Locations: Interior side of exterior walls.
3. Stainless-Steel:
 - a. Location: Wet locations, such as toilet rooms, kitchen areas, and other areas subject to high humidity.

C. Ratings: Provide fire-rated access doors for doors located in rated assemblies, as indicated on Drawings.

END OF SECTION 083113

SECTION 083613 - 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. Section 055000 "Metal Fabrications" for miscellaneous steel supports.
 - 2. Section 079200 - Joint Sealants: Perimeter sealant and backup material.

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.

3. Panel for raised-panel door sections; not smaller than required to show raised-panel profile.
4. Exhaust port.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sectional doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Failure of components or operators before reaching required number of operation cycles.
 - c. Faulty operation of hardware.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - e. Delamination of exterior or interior facing materials.
 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain sectional doors from single source from single manufacturer.
 - 1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Sectional doors shall comply with performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward.
 - 2. Testing: According to ASTM E330[or DASMA 108 for garage doors and complying with the acceptance criteria of DASMA 108.
 - 3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
 - a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of the door width.
 - b. Deflection of horizontal track assembly shall not exceed 1/240 of the door height.
 - 4. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa) wind load, acting inward and outward.
- C. Windborne-Debris Impact Resistance: Provide glazed sectional doors that pass ASTM E1886 missile-impact and cyclic-pressure tests according to ASTM E1996 for Wind Zone 3 or DASMA 115 for enhanced protection.
 - 1. Large Missile Test: For overhead coiling doors located within 30 feet (9.144 m) of grade.
- D. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.5.

2.3 DOOR ASSEMBLY

- A. Glazed Aluminum Sectional Overhead Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated. Basis-of-Design: Titan Model by Arm-R-Lite.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arm-R-Lite. (Basis-of-Design).
 - b. Clopay
 - c. Raynor.
- B. Operation Cycles: Door components and operators capable of operating for not less than 10,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Air Infiltration: Polyurethane expanding foam filled insulated rails and stiles with water resistant feature.
- D. Installed R-Value: .67.
- E. Aluminum Sections: Full vision.
- F. Track Configuration: High-lift.
- G. Weatherseals: Fitted to bottom and top and around entire perimeter of door.
- H. Windows: As indicated on Drawings with glazing of the following type:
 1. Insulating Glass: 5/8" insulated tempered safety glass with SB70 Low E – Argon filled with approximate U-Factor of .67. See Sections 088000 and 088113 for glazing types.
- I. Roller-Tire Material: Manufacturer's standard.
- J. Locking Devices: Equip door with locking device assembly.
 1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumbturn.
- K. Electric Door Operator:
 1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
 2. Operator Type: Manufacturer's standard for door requirements.
 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
 4. Motor Exposure: Interior, clean, and dry.
 5. Emergency Manual Operation: Chain type.
 6. Obstruction-Detection Device: Manufacturer's standard Automatic.
 7. Control Station: Interior-side mounted.
8. Other Equipment: Audible and visual signals.
- L. Door Finish:

1. Baked-Enamel or Powder-Coat Finish: Custom Color and gloss matching Architect's sample.
2. Finish of Interior Facing Material: Match finish of exterior section face.

2.4 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 ALUMINUM DOOR SECTIONS

- A. Sections: Extruded-aluminum stile and rail members with dimensions and profiles as indicated on Drawings; members joined by welding or with concealed, **1/4-inch- (6-mm-)** minimum diameter, aluminum or nonmagnetic stainless-steel through bolts, full height of door section; and with meeting rails shaped to provide a weather-resistant seal.
 1. Aluminum: **ASTM B221 (ASTM B221M)** extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; minimum thickness **0.065 inch (1.7 mm)** for door section **1-3/4 inches (44 mm)** deep, and as required to comply with requirements.
 2. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
 3. Provide reinforcement for hardware attachment.
- B. Full-Vision Sections: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, clear acrylic glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops.

2.6 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances indicated on Drawings, Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides for required door type, size, weight, and loading.
 1. Galvanized Steel: ASTM A653/A653M, minimum **G60 (Z180)** zinc coating.
 2. Slope tracks at an angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
 3. Track Reinforcement and Supports: Galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced **2 inches (51 mm)** apart for door-drop safety device.
- B. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

- C. Windows: Manufacturer's standard window units of type, size, and in arrangement indicated. Set glazing in vinyl, rubber, or neoprene glazing channel, as required. Provide removable stops of same material as door-section frames.

2.7 HARDWARE

- A. General: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- (2.01-mm-) nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible. Provide double-end hinges where required, for doors more than 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.
- C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.
- D. Push/Pull Handles: Equip each push-up operated or emergency-operated door with galvanized-steel lifting handles on each side of door, finished to match door.

2.8 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: Cylinders standard with manufacturer[and keyed to building keying system.
 - 2. Keys: Two for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 COUNTERBALANCE MECHANISM

- A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A229/A229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.

- B. Weight Counterbalance: Counterbalance mechanism consisting of filled pipe weights that move vertically in a galvanized-steel weight pipe. Connect pipe weights with cable to weight-cable drums mounted on torsion shaft made of steel tube or solid steel.
- C. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.
- D. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.
- E. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.
- F. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
- G. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
 - 1. Trolley: Trolley operator mounted to ceiling above and to rear of door in raised position and directly connected to door with drawbar.
 - 2. Jackshaft, Center Mounted: Jackshaft operator mounted on the inside front wall above door and connected to torsion shaft with an adjustable coupling or drive chain.
 - 3. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.
- D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.

1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 460 V.
 - c. Hertz: 60.
 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than **8 in./sec. (203 mm/s)** and not more than **12 in./sec. (305 mm/s)**, without exceeding nameplate ratings or service factor.
 3. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
 5. Use adjustable motor-mounting bases for belt-driven operators.
- E. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction Detection Device: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
 2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom section. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire configured device designed to interface with door-operator control circuit to detect damage to or disconnection of sensor edge.
 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure, push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

- H. Emergency Manual Operation: Equip electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N).
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
- L. Portable, Radio-Control System: Consisting of one of the following:
 - 1. Three-channel universal coaxial receiver to open, close, and stop door.
 - 2. Portable control device to open and stop door may be momentary-contact type; control to close door shall be sustained- or constant-pressure type.
 - 3. Remote antenna and mounting kit.

2.11 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches (610 mm) apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 083613

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Exterior and interior storefront framing.
- 2. Storefront framing for punched openings.
- 3. Exterior and interior manual-swing entrance doors and door-frame units.
- 4. Venting windows.

B. Related Requirements:

- 1. Section 079200 "Joint Sealants."
- 2. Section 088000 "Glazing."

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

- 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
- 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
- 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, licensed in the State of Maryland, responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and field-testing agency.
- B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:

- a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to **3/4 inch (19.1 mm)**, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or **1/8 inch (3.2 mm)**, whichever is smaller.
 - a. Operable Units: Provide a minimum **1/16-inch (1.6-mm)** clearance between framing members and operable units.
- E. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of **0.06 cfm/sq. ft. (0.30 L/s per sq. m)** at a static-air-pressure differential of **6.24 lbf/sq. ft. (300 Pa)**.
 2. Entrance Doors:
 - a. Pair of Doors: Maximum air leakage of **1.0 cfm/sq. ft. (5.08 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.
 - b. Single Doors: Maximum air leakage of **0.5 cfm/sq. ft. (2.54 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **10 lbf/sq. ft. (480 Pa)**.
- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor):

- a. Fixed glazing and framing areas shall have U-factor of not more than **0.33 Btu/sq. ft. x h x deg F** as determined according to NFRC 100.
 - b. Entrance system glazing and framing shall have U-factor of not more than **0.52 Btu/sq. ft. x h x deg F** as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 60 as determined according to NFRC 500.
- I. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows.
 1. Outdoor-Indoor Transmission Class: Minimum 26.
 - J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.
- 2.2 MANUFACTURERS
- A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP America Inc.; YOW 350 TUH or a comparable product by one of the following:
 1. EFCO Corporation.
 2. Kawneer North America; an Alcoa company.
 3. Oldcastle Building Envelope™.
 4. U.S. Aluminum; a brand of C.R. Laurence.
 - B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing, venting windows, and accessories, from single manufacturer.
- 2.3 FRAMING
- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Construction:
 - a. Exterior: Thermally broken.
 - b. Interior: Non-thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Finish and Color: High-Performance Organic Coating: Delaware Technical Community College Custom Blue.
 5. Fabrication Method: Field-fabricated stick system.
 - B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
 - C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: **ASTM B 209 (ASTM B 209M)**.
 - b. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B 221 (ASTM B 221M)**.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 VENTING WINDOWS

A. Aluminum Windows: Manufacturer's units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:

1. Basis-of-Design: YKK AP America, Inc.; YOW 350 XT.
2. Window Type: Casement.
3. Minimum Performance Class: AW.
4. Minimum Performance Grade: 40.
5. Aluminum Extrusions: **ASTM B 221 (ASTM B 221M)**, alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than **0.064-inch (1.63-mm)** thickness at any location for main frame and sash members.
 - a. Thermally Broken Construction: Fabricate window units with multiple, integral, concealed, low-conductance thermal barriers; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
6. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.
7. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners shall not be exposed, except for attaching hardware.
 - a. Reinforcement: Where fasteners screw-anchor into aluminum less than **0.128 inch (3.26 mm)** thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.
8. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
 - a. Cam-action sweep sash lock and keeper at meeting rails.
 - b. Spring-loaded, snap-type lock at jambs.
 - c. Pole-operated, cam-action locking device on meeting rail where rail is more than **72 inches (1830 mm)** above floor.
 - d. Lift handles for single-hung units.

- e. Nylon sash rollers for horizontal-sliding units.
 - f. Steel or bronze operating arms.
9. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
- a. Aluminum Wire Fabric: 18-by-18 (1.1-by-1.1-mm), 18-by-16 (1.1-by-1.3-mm), or 18-by-14 (1.1-by-1.5-mm) mesh of 0.013-inch- (0.3-mm-) diameter, coated aluminum wire.
- B. Glazing: Same as adjacent aluminum-framed entrances and storefront glazing.
- C. Finish: Match adjacent aluminum-framed entrances and storefront finish.

2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's glazed entrance doors for manual-swing operation.
- 1. Basis-of-Design: YKK AP America, Inc.; MegaTherm 50 XT.
 - 2. Door Construction: 2-3/8-inch (60.3-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 - 3. Door Design: Wide stile; 5-inch (127-mm) nominal width.
 - 4. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.

2.6 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087101 "Door Hardware Schedule" and Section 087100 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
- 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 - 3. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
 - b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.

2.7 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: Comply with Section 088000 "Glazing."

2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of **1 inch (25.4 mm)** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate components for assembly using shear-block system.

- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color: Delaware Technical Community College Custom Blue.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.

3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

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

- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

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

END OF SECTION 084113

SECTION 085150 – SLIDING SERVICE WINDOWS

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 manually operated sliding service windows at Tool Room 105.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Sliding service windows shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

1.4 SUBMITTALS

- A. Product Data: For each type and size of sliding service windows. Include the following:
 - 1. Construction details, material descriptions, dimensions of individual components, profile sections, and finishes.
 - 2. Operating characteristics and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on samples.
- E. Qualification Data: For qualified Installer.
- F. Maintenance Data: To include in maintenance manuals.
- G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain sliding service windows from single source from single manufacturer.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sliding service windows that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - d. Delamination of exterior or interior facing materials.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ALUMINUM SLIDING SERVICE WINDOWS

- A. Construction: All windows to be surface mounted with no obstruction or grooves in counter. The bottom channel of vertical and horizontal sliding windows are fitted with a wool pile seal on the active sash for counter contact.
- B. Material: Frames and glass channels of heavy type 6063-T5 aluminum extrusions.
- C. Glass: Factory-installed.

2.2 HARDWARE

- A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit window type.
- B. Locks: Key type.

2.3 SEALS

- A. General: Brush type wool pile counter seal.

2.4 SLIDING SERVICE WINDOW ASSEMBLY (W-#)

- A. Full-Vision Aluminum Sliding Service Window.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, Model BP by Nissen & Company, or comparable product.
- B. Size: As noted on drawings.
- C. Glazing: Factory-installed ¼" (6.4mm) clear tempered glass, non-insulated.
- D. Locking Devices: Equip door with key locking device assembly.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

- A. Baked enamel Finish.
 - 1. Color: Custom.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sliding windows complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Place complete frame and window assembly on counter between jambs. Attach to jambs by concealed screws through channel walls.

- C. Accessibility: Install assembly in compliance with regulatory requirements for accessibility.

3.3 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that sliding windows operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

END OF SECTION 085150

SECTION 086213 – DOMED UNIT SKYLIGHTS

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. Domed unit skylights mounted on curbs.

- B. Related Requirements:

- 1. Section 133419 "Metal Building Systems" for roof system in which domed unit skylights are installed.
- 2. Section 012300 "Alternates."

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of domed unit skylight.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for domed unit skylights.
- 2. Motors: Show nameplate data, power requirements, ratings, characteristics, and mounting arrangements.

- B. Shop Drawings: For domed unit skylight work.

- 1. Include plans, elevations, sections, details, and connections to supporting structure and other adjoining work.
- 2. Multiple Units: Methods of connection and structural support for multiple units clustered together.

- C. Aluminum Finish Samples: For each type of exposed finish required, in a representative section of each domed unit skylight in manufacturer's standard size.

- D. Glazing Samples: For each color and finish of glazing indicated, 12 inches (300 mm) square and of same thickness indicated for the final Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Product Test Reports: For each type and size of unit skylight, for tests performed within the last four years by a qualified testing agency. Test results based on testing of smaller unit skylights than specified will not be accepted.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For domed unit skylights to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating domed unit skylights that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations, and regularly engaged for the past ten years in manufacture of skylights similar to those specified.
- B. Installer Qualifications: An installer acceptable to domed unit skylight manufacturer for installation of units required for this Project, regularly engaged for the past five years in installation of skylights similar to those specified, and employing persons trained for installation of skylights.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of domed unit skylights that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Uncontrolled water leakage.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Yellowing of acrylic glazing.
 - d. Breakage of polycarbonate glazing.
 - e. Deterioration of insulating-glass hermetic seal.
 - 2. Warranty Period:
 - a. Leaks: 20 years from date of Substantial Completion.
 - b. Less than 7 percent visible light transmittal loss over 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide by Prismatic Skylight by Nucor Building Systems or comparable product by one of the following:
1. Manufacturer as recommended in writing by Metal Building System manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Domed Unit Skylight Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
1. Performance Class and Grade: Class CW-PG 30.
 2. Certification: NFRC- and NAFS-certified domed unit skylights with label attached to each.
- B. Thermal Transmittance: NFRC 100 maximum U-factor of 0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K).
- C. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum SHGC of 0.40.
- D. Windborne-Debris-Impact Resistance: Provide domed unit skylights that pass basic-protection testing requirements in ASTM E 1996 for Wind Zone 2 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than domed unit skylights indicated for use on Project and shall be installed in same manner as domed unit skylights indicated for use on Project.
1. Small-Missile Test: For domed unit skylights located more than 30 feet (9.1 m) above grade.
- E. Factory Mutual: Provide domed unit skylights approved by Factory Mutual.

2.3 DOMED UNIT SKYLIGHTS

- A. General: Provide factory-assembled domed unit skylights that include glazing, extruded-aluminum glazing retainers, gaskets, and inner frames and that are capable of withstanding performance requirements indicated.
- B. Shape and Size: Square, 48-by-48-inch (1219-by-1219-mm).
- C. Polycarbonate Glazing: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated according to UL 972, and with average impact strength of 12 to 16 ft-lb/in. (640 to 854 J/m) of width when tested according to ASTM D 256, Test Method A (Izod).
1. Double-Glazing Profile: Dome, 25 percent rise.
 - a. Thicknesses: Not less than thicknesses required to exceed performance requirements.
 - b. Outer and Inner Glazing: Polycarbonate with exterior UV cap prismatic lens.
 2. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested according to ASTM D 1929.

3. Smoke-Production Characteristics: Smoke-developed index of 450 or less when tested according to ASTM E 84, and smoke density of 75 or less when tested according to ASTM D 2843
4. Burning Characteristics: Tested according to ASTM D 635. Class CC1, burning extent of **1 inch (25 mm)** or less for nominal thickness of **0.060 inch (1.5 mm)** or thickness indicated for use.

D. Glazing Gaskets: Manufacturer's standard.

E. Integral Curb: Extruded-aluminum, self-flashing type.

1. Extruded-Aluminum Shapes: **ASTM B 221 (ASTM B 221M)**, alloy and temper to suit structural and finish requirements but with not less than the strength and durability of Alloy 6063-T52.
2. Height: As required by Skylight and Metal Building System manufacturers.
3. Construction: Single or double wall.
4. Insulation: As part of Metal Building System roof assembly.

F. Condensation Control: Fabricate domed unit skylights with integral internal gutters and nonclogging weeps to collect and drain condensation to the exterior.

G. Thermal Break: Fabricate domed unit skylights with thermal barrier separating exterior and interior metal framing.

2.4 ACCESSORY MATERIALS

A. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.

1. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.

B. Bituminous Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat.

2.5 FABRICATION

A. Factory assembled skylights and glazed ready for installation.

B. Fabricate skylights to be weathertight and free of visual distortions and defects.

C. Protect exterior drip/counterflashing and drainage ports from weather and airborne debris.

D. Miter and full-penetration weld corners of curb and retaining frames.

E. Retaining Frames:

1. Retaining frames that secure glazing panels along each side under spring tension need not be welded.
2. Seal with urethane sealant along full perimeter of retaining frames.
3. Pre-drill skylight frames for anchorage to self-curbing solution.

F. Seal glazing panels to base frame to allow for sufficient expansion and contraction.

1. Provide exterior weep hole arrangement.

2.6 ALUMINUM FINISHES

- A. Mill Finish: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, 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 INSTALLATION

- A. Coordinate installation of domed unit skylight with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.
- B. Comply with recommendations in AAMA 1607 and with manufacturer's written instructions for installing domed unit skylights.
- C. Install domed unit skylights level, plumb, and true to line, without distortion.
- D. Anchor domed unit skylights securely to supporting substrates.
- E. Where aluminum surfaces of domed unit skylights will contact another metal or corrosive substrates, such as preservative-treated wood, apply bituminous coating on concealed metal surfaces or provide other approved permanent separation recommended in writing by domed unit skylight manufacturer.

3.3 CLEANING

- A. Clean exposed domed unit skylight surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes.
- B. Remove excess sealants, glazing materials, dirt, and other substances.
- C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect domed unit skylight surfaces from contact with contaminating substances resulting from construction operations.

END OF SECTION 086213

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Automatic operators.
 - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section “Door Hardware Schedule”.
 - 2. Division 08 Section “Hollow Metal Doors and Frames”.
 - 3. Division 08 Section “Automatic Door Operators”.
 - 4. Division 08 Section “Access Control Hardware”.
 - 5. Division 28 Section “Access Control”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. UL/ULC and CSA C22.2 – Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
 - 8. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.
- 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
 - C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
 - E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
 - F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
 - G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
 - H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.
 - 3. Five years for motorized electric latch retraction exit devices.

4. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

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

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

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

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.

- b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
- B. Pivots: ANSI/BHMA A156.4, Grade 1, certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door. Pivots to be UL listed for windstorm where applicable.
 1. Manufacturers:
 - a. Rixson Door Controls (RF).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
- B. Electrified Quick Connect Intermediate Transfer Pivots: Provide electrified offset intermediate transfer pivot hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Manufacturers:

- a. Rixson Door Controls (RF) - E-M19-QC (# wires).
- C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
 2. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.

2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.
1. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
2. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
3. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
 1. Manufacturers:
 - a. Sargent Manufacturing (SA).
 - b. No Substitution.
- C. Cylinders: Original manufacturer cylinders complying with the following:
 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
- D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (small or large format) as specified in Hardware Sets.
- E. Keying System: Each type of lock and cylinders to be factory keyed.
 1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. Existing System: Key locks to Owner's existing system.
- F. Key Quantity: Provide the following minimum number of keys:
 1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).

3. Construction Keys (where required): Ten (10).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

- a. Sargent Manufacturing (SA) – 8200 Series.
- b. No Substitution.

2.7 INTEGRATED WIEGAND OUTPUT LOCKING DEVICES – MULTI-CLASS READER

- A. Integrated Wiegand Output Multi-Class Mortise Locks: Wiegand output ANSI A156.13, Grade 1, mortise lockset with integrated card reader, request-to-exit signaling, door position status switch, and latchbolt monitoring in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt. Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.

1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Latchbolt monitoring and door position switch act in conjunction to report door-in-frame (DPS) and door latched (door closed and latched) conditions.
2. Integrated reader supports the following credentials:
 - a. 125kHz proximity credentials: HID, AWID, Indala, and EM4102.
 - b. 13.56 MHz proximity credentials: HID iClass, HID iClass SE, SE for MIFARE Classic, DESFire EV1.
3. 12VDC external power supply required for reader and lock, with optional 24VDC lock solenoid. Fail safe or fail secure options.
4. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
5. Support end-of-line resistors contained within the lock case.
6. Installation requires only one cable run from the lock to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
7. Installation to include manufacturer's access control panel interface board or module where required for Wiegand output protocol.
8. Manufacturers:
 - a. Sargent Manufacturing (SA) – M1 8200 Series.

2.8 AUXILIARY LOCKS

- A. Push-Pull Latches, Paddle Type, Mortise: ANSI/BHMA A156.13, Series 1000, Operational and Security Grade 1 mortise type push-pull locks and latches with ligature-resistant paddle trim capable of being mounted in vertical (up or down) and horizontal (sideways) positions. Locksets to be manufactured with a corrosion resistant, formed steel case and be non-handed, field-reversible for re-handing without disassembly of the lock body. Paddles and covers are manufactured from cast stainless steel or brass material. Provide optional lead-lining (lock body) and Torx® fasteners as specified in Hardware Sets.

1. Manufacturers:

- a. Sargent Manufacturing (SA) - 8200 ALP Series.

2.9 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

- B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the

proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 80 Series.
 - b. No Substitution.

2.11 INTEGRATED WIEGAND OUTPUT EXIT DEVICES – MULTI-CLASS READER

- A. Integrated Wiegand Output Multi-Class Exit Hardware: Wiegand output ANSI 156.3 Grade 1 rim, mortise, and vertical rod exit device hardware with integrated proximity card reader, latchbolt and touchbar monitoring, and request-to-exit signaling, in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle exit trim with 3/4" throw latch bolt. U.L listed and labeled for either panic or "fire exit hardware" for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.
1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Inside push bar (request-to-exit) signaling and door position (open/closed status) monitoring (via separately connected DPS).
 2. Integrated reader supports the following credentials:
 - a. 125kHz proximity credentials: HID, AWID, Indala, and EM4102.
 - b. 13.56 MHz proximity credentials: HID iClass, HID iClass SE, SE for MIFARE Classic, DESFire EV1.
 3. 12VDC external power supply required for reader. 24VDC required for solenoid operated exit trim. Fail safe or fail secure options.
 4. Installation requires only one cable run from the exit hardware to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
 5. Competitor Alternates Allowed Option>Installation to include manufacturer's access control panel interface board or module where required for Wiegand output protocol.
 6. Manufacturers:
 - a. Sargent Manufacturing (SA) – M1 80 Series.

2.12 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 281 Series.
 - b. No Substitution.

2.13 ELECTROHYDRAULIC DOOR OPERATORS

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
1. 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.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:
1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Norton Door Controls (NO) - 6000 Series.

2.14 ARCHITECTURAL TRIM

- A. Door Protective Trim
 - 1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
 - 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
 - 3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
 - 4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
 - 5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
 - 6. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.15 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 - 1. Manufacturers:
 - a. Rixson Door Controls (RF).

2.16 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.17 ELECTRONIC ACCESSORIES

- A. Key Switches: Key switches furnished standard with stainless steel single gang face plate with a 12/24VDC bi-color LED indicator. Integral backing bracket permits integration with any 1 1/4" or 1 1/2" mortise type cylinder. Key switches available as momentary or maintained action and in narrow face plate options.
 - 1. Manufacturers:
 - a. Securitron (SU) - MK Series.
- B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
 - 1. Manufacturers:
 - a. Securitron (SU) - DPS Series.
- C. Wiegand Test Unit: Test unit verifies proper Wiegand output integrated card reader lock installation in the field by testing for proper wiring, card reader data integrity, and lock functionality including lock/unlock, door position, and request-to-exit status. 12 or 24VDC voltage adjustable operating as Fail Safe or Fail Secure.
 - 1. Manufacturers:
 - a. Sargent Manufacturing (SA) – WT2 Wiegand Test Unit.

2.18 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.
- C. Refer to Section 080671, Door Hardware Sets, for hardware sets.

END OF SECTION 087100

SECTION 087101 – DOOR HARDWARE SCHEDULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section references specification sections relating to commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding Doors.
 - 3. Other doors to the extent indicated.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical and access control door hardware.
 - 3. Electromechanical and access control door hardware power supplies, back-ups and surge protection.
 - 4. Automatic operators.
 - 5. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section “Hollow Metal Doors and Frames”.
 - 2. Division 08 Section “Door Hardware”.
 - 3. Division 08 Section “Automatic Door Operators”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: Reference Related Sections for requirements regarding compliance with applicable industry standards.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service

representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum [5] years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum [3] years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum [5] years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of Door Hardware specified in the Related Sections from a single source, qualified supplier unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the applicable model building code.
- F. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.8 MAINTENANCE SERVICE

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

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Refer to "PART 3 – EXECUTION" for required specification sections.

PART 3 - EXECUTION

3.1 DOOR HARDWARE SETS

- A. The door hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a

hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.
- C. Products listed in the Door Hardware Sets must meet the requirements described in the specification sections noted.
 - 1. Section 08 71 00 – Door Hardware.
- D. Materials to be furnished in accordance to Premier/ASSA ABLOY GPO Contract #PP-FA-663.
- E. Manufacturer’s Abbreviations:
 - 1. MK - McKinney
 - 2. RF - Rixson
 - 3. RO - Rockwood
 - 4. SA - SARGENT
 - 5. NO - Norton
 - 6. PE - Pemko
 - 7. SU - Securitron

Hardware Sets

Set: 1.0

Doors: 100/1

2 Pivot Set	147	626	RF
2 Electrified Int. Pivot	EM19 QC	626	RF
1 Exit Device (nightlatch)	63 55 56 AD8410 106	US32D	SA
1 Exit Device (exit only)	55 56 AD8410	US32D	SA
1 Cylinder	63 (as required)	US15	SA
2 Core	6300	US15	SA
2 Door Pull	RM2240-50	US32D	RO
2 Overhead Stop	1-X36 (heavy duty concealed)	630	RF
2 Door Operator	6010/6020	689	NO
1 Threshold	274x4AFG MSES25SS		PE
1 Gasketing	by door supplier		
4 ElectroLynx Harness	QC-C (as needed)		MK
1 Card Reader	by others		

2 Position Switch	DPS2-M/W-BK	SU
1 Keyswitch	MKA	SU
1 Operator Switch/Post	500	NO
1 Operator Switch	700 (wave-to-open)	NO
1 Power Supply	AQD4-8C8R2	SU
1 Wiring Diagrams	elevation and point-to-point (as required)	

Notes:

- Opening(s) normally closed and locked from pull side.
- Use of valid credential to allow use of exterior operator switch and retract exit device rail for entry.
- Free egress and use of interior operator switch always allowed.
- Changing state of keyswitch to allow/disallow use of exterior operator switch without a valid credential during desired hours.
- Coordinate amperage for all openings and consolidate the number power supplies as able.

Set: 2.0

Doors: 106/14, 106/2, 106/7, 106/8

2 Hinge (heavy weight)	T4A3386 NRP FT	US32D	MK
1 Hinge (heavy weight)	T4A3386 NRP QC FT	US32D	MK
1 Exit Device (card reader)	63 (12) M1-8876 (B/F)IPS ETMG	US32D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
1 Threshold	274x4AFG MSES25SS		PE
1 Gasketing	29313CPK TKSP8		PE
1 Door Bottom	217AV TKSP8		PE
2 ElectroLynx Harness	QC-C (as needed)		MK
1 Power Supply	AQD4-8C8R2		SU
1 Wiring Diagrams	elevation and point-to-point (as required)		

Notes:

- Opening(s) normally closed and locked.
- Use of valid credential to unlock lever trim to allow entry.
- Free egress always allowed from interior. Exit device trim is fail secure.
- Coordinate amperage for all openings and consolidate the number power supplies as able.

Set: 3.0

Doors: 100/2

2 Pivot Set	147	626	RF
2 Intermediate Pivot	M19	626	RF
4 Door Pull	RM2240-50	US32D	RO
2 Door Operator	6010/6020	689	NO
2 Kick Plate	K1050 10" CSK BEV	US32D	RO
2 Door Stop	RM861/RM855	US26D	RO
2 Silencer	608		RO
2 Operator Switch	700 (wave-to-open)		NO
2 Sign	RM1110H (PUSH)	US32D	RO
2 Sign	RM1110L (PULL)	US32D	RO

Set: 4.0

Doors: 105/1

2 Hinge	TA2714 FT	US26D	MK
1 Hinge	TA2714 QC FT	US26D	MK
1 Card Reader Lock	63 M1-82271 (B/F)IPS CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
1 Gasketing	S44BL (rated openings)		PE
3 Silencer	608 (non-rated openings)		RO
1 ElectroLynx Harness	QC-C (as needed)		MK
1 Power Supply	AQD4-8C8R2		SU
1 Wiring Diagrams	elevation and point-to-point (as required)		

Notes:

- Opening(s) normally closed and locked.
- Use of valid credential to unlock lever trim to allow entry.
- Lockset is fail-secure; will remain locked without power.
- Free egress always allowed from interior.
- Coordinate amperage for all openings and consolidate the number power supplies as able.

Set: 5.0

Doors: 114/1

6 Hinge	TA2714 FT	US26D	MK
1 Flush Bolt (set)	2845/2945 (combination)	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	63 8204 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Coordinator	2600 TORX	Black	RO
2 Door Closer	MC 281 O/P9	EN	SA
2 Kick Plate	K1050 10" CSK BEV	US32D	RO
2 Door Stop	RM861/RM855	US26D	RO
1 Gasketing	S44BL (rated openings)		PE
1 Astragal	29324CNB TKSP8 (rated openings)		PE
2 Silencer	608 (non-rated openings)		RO

Set: 6.0

Doors: 107/1, 108/1

3 Hinge	TA2714 FT	US26D	MK
1 Storeroom Lock	63 8204 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
1 Gasketing	S44BL (rated openings)		PE
3 Silencer	608 (non-rated openings)		RO

Set: 7.0

Doors: 109/1

3 Hinge	TA2714 FT	US26D	MK
1 Storeroom Lock	63 8204 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 CPS (stop arm)	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Gasketing	S44BL (rated openings)		PE
3 Silencer	608 (non-rated openings)		RO

Set: 8.0

Doors: 102/1, 103/1

3 Hinge	TA2714 FT	US26D	MK
1 Office Lock	63 8205 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
3 Silencer	608		RO

Set: 9.0

Doors: 105/2, 106/1

6 Hinge	TA2714 FT	US26D	MK
1 Flush Bolt (set)	2845/2945 (combination)	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Classroom Lock	63 8237 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Coordinator	2600 TORX	Black	RO
2 Door Closer	MC 281 O/P9	EN	SA
2 Kick Plate	K1050 10" CSK BEV	US32D	RO
2 Door Stop	RM861/RM855	US26D	RO
1 Gasketing	S44BL (rated openings)		PE
1 Astragal	29324CNB TKSP8 (rated openings)		PE
2 Silencer	608 (non-rated openings)		RO

Set: 10.0

Doors: 105/3

3 Hinge	TA2714 FT	US26D	MK
1 Classroom Lock	63 8237 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
3 Silencer	608		RO

Set: 10.1

Doors: 104/1, 110/1

3 Hinge	TA2714 FT	US26D	MK
1 Classroom Lock	63 8237 CRNJ	US26D	SA
1 Core	6300	US15	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
3 Silencer	608		RO

Set: 11.0

Doors: 111/1, 112/1

3 Hinge	TA2714 FT	US26D	MK
1 Passage Latch	8215 ALP	US32D	SA
1 Door Closer	MC 281 O/P9	EN	SA
1 Kick Plate	K1050 10" CSK BEV	US32D	RO
1 Door Stop	RM861/RM855	US26D	RO
1 Gasketing	S44BL (rated openings)		PE
3 Silencer	608 (non-rated openings)		RO

Set: 12.0

Doors: 106/10, 106/11, 106/12, 106/13, 106/3, 106/4, 106/5, 106/6, 106/9

1 All Hardware by others

Set: 13.0

1 Test Unit WT1 SA ⚡

END OF SECTION 087101

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Glass for windows, doors, interior borrowed lites, storefront framing and sectional doors.
 - 2. Glazing sealants and accessories.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- B. Contractor is responsible for complying with applicable codes and standards with regards to provision and installation of the proper glazing materials. Drawings and Specifications may not identify all glass type locations.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Glazing Accessory Samples: For sealants, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, glass testing agency and sealant testing agency.
- B. Product Certificates: For glass.
- C. Product Test Reports: For tinted glass, coated glass, insulating glass, and glazing sealants, for tests performed by a qualified testing agency.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.12 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers, General: Subject to compliance with requirements, provide products by one of the following:
1. Cardinal Glass Industries.
 2. Pilkington North America.
 3. PPG Flat Glass; PPG Industries, Inc.
 4. Vetrotech Saint-Gobain.
 5. Viracon, Inc.
- B. Manufacturers, Fire-Protection and Fire-Resistance Glazing: Subject to compliance with requirements, provide products by one of the following:
1. Pilkington North America.
 2. SAFTI FIRST, a division of O'Keefe's Inc.
 3. Technical Glass Products.
 4. Vetrotech Saint-Gobain.
- C. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain insulated glass from single source from single source from single manufacturer.
 2. Obtain fire-protection and fire-resistance glass from single source from single manufacturer.
- D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Drawings.
 2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as **Btu/sq. ft. x h x deg F (W/sq. m x K)**.
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 2. IGMMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IgCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
1. Minimum Glass Thickness for Exterior Lites: 6 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
- C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

- D. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

- 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

- 1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.

- 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Spacer: Manufacturer's standard spacer material and construction.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 FIRE-PROTECTION AND FIRE-RESISTANCE GLAZING

- A. Provide fire-protection and fire-resistance rated glazing with ratings as scheduled on Drawings.

- B. Fire-Resistance Glazing:

- 1. Basis-of-Design: Technical Glass Products; FireLite Plus

- C. Fire-Protection Glazing:

- 1. Basis-of-Design: Pilkington; Pyrostop.

2.8 GLAZING SEALANTS

- A. General:

- 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

2.9 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.10 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.11 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant where indicated.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type GL-1: Clear annealed float glass.
 - 1. Minimum Thickness: 6 mm.
- B. Glass Type GL-2 Clear heat-strengthened float glass.
 - 1. Minimum Thickness: 6 mm.
- C. Glass Type GL-3 (**TEMP**): Clear fully tempered float glass.
 - 1. Minimum Thickness: 6 mm.
 - 2. Safety glazing required.

3.9 LAMINATED GLASS SCHEDULE

A. Glass Type GL-5 (**LAM**): Clear laminated glass with two plies of annealed float glass.

1. Basis-of-Design Product: Viracon; Polyvinyl Butyral Laminated Glazing.
2. Minimum Thickness of Each Glass Ply: 3 mm.
3. Interlayer Thickness: **0.030 inch (0.76 mm)**.
4. Safety glazing required.

3.10 INSULATING GLASS SCHEDULE

A. Glass Type GL-6 (**IG-1**): Low-E-coated, clear insulating glass.

1. Basis-of-Design Product: PPG; Solarban 60 (2) Clear + Clear.
2. Overall Unit Thickness: **1 inch (25 mm)**.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Fully tempered float glass.
5. Interspace Content: 90% Argon, 10% Air.
6. Indoor Lite: Fully tempered float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Visible Light Transmittance: 70 percent minimum.
10. Solar Heat Gain Coefficient: 0.40 maximum.
11. Cradle-to-Cradle (C2) Certification: Silver.
12. Safety glazing required.

B. Glass Type GL-7 (**IG-2**): Low-E-coated, clear and acid-etched insulating glass.

1. Basis-of-Design Product: Vitro Architectural Glass Solarban 60 (2) Clear + Acid-etched.
2. Overall Unit Thickness: **1 inch (25 mm)**.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Fully tempered float glass.
5. Interspace Content: 90% Argon, 10% Air.
6. Indoor Lite: Fully tempered acid-etched float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Visible Light Transmittance: 70 percent minimum.
10. Solar Heat Gain Coefficient: 0.40 maximum.
11. Cradle-to-Cradle (C2) Certification: Silver.
12. Safety glazing required.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Non-load-bearing steel framing systems for interior partitions.
- 2. Suspension systems for interior ceilings and soffits.
- 3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

- 1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Studs and Runners: Provide documentation that framing members' certification is according to SIFA's "Code Compliance Certification Program for Cold-Formed Steel Structural and Non-Structural Framing Members."

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For embossed steel studs and runners and firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645. Use either steel studs and runners or embossed steel studs and runners.
 - 1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: As required by performance requirements for horizontal deflection but not less than 0.0269 inch (0.683 mm).
 - b. Depth: As indicated on Drawings.
 - 2. Embossed Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: As required by horizontal deflection performance requirements but not less than 0.0147 inch (0.373 mm).
 - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
- E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 1-1/2 inches (38 mm).
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
 - 2. Depth: As indicated on Drawings.
- G. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Hat shaped.
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide Dietrich Metal Framing; RC-2 ProPlus, or equivalent product approved by Architect.

- H. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: As indicated on Drawings.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 1-1/2 inches (38 mm).
- D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
 - b. Depth: As indicated on Drawings.
 3. Embossed Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0147 inch (0.373 mm).
 - b. Depth: As indicated on Drawings.
 4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; 640/660 Drywall Ceiling Suspension.
 - c. United States Gypsum Company; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, **1/8 inch (3.2 mm)** thick, in width to suit steel stud size.
- C. Resilient Sound Isolation Clip:
 1. Basis-of-Design: PAC International; RSIC-1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches (610 mm)** o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.

- b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6 inches (150 mm)** o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: **48 inches (1219 mm)** o.c.
 - 2. Carrying Channels (Main Runners): **48 inches (1219 mm)** o.c.
 - 3. Furring Channels (Furring Members): **16 inches (406 mm)** o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Do not attach hangers to steel roof deck.
 - 5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. 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.

- F. Installation Tolerances: Install suspension systems that are level to within **1/8 inch in 12 feet** (**3 mm in 3.6 m**) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior gypsum board.

- B. Related Requirements:

- 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Samples: For the following products:

- 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, moisture damaged, and mold damaged.

- 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Provide regular gypsum board with minimum 80 percent recycled content, including recycled content face paper.
- C. Gypsum board and sound attenuation blankets: Comply with California Department of Public Health (CDPH) Standard Method v1.1–2010 or GREENGUARD Gold certification.
- D. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. **Georgia-Pacific Building Products;** ToughRock Brand Fireguard X.
 - b. **National Gypsum Company;** Gold Bond Brand Fire-Shield Wallboard.
 - c. **United States Gypsum Company;** USG Sheetrock® Brand Firecode® X Gypsum Panels.
 2. Thickness: **5/8 inch (15.9 mm).**
 3. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- B. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. **Georgia-Pacific Building Products;** ToughRock Brand FlexRoc Gypsum Board.
 - b. **National Gypsum Company;** High Flex Brand Wallboard.
 - c. **United States Gypsum Company;** USG Sheetrock® Brand Flexible Gypsum Panels.
 2. Thickness: **1/4 inch (6.4 mm).**
 3. Long Edges: Tapered.
- C. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Georgia-Pacific Building Products; ToughRock Brand Fireguard X Abuse-Resistant Gypsum Board.
 - b. National Gypsum Company; Hi-Abuse Brand XP Fire-Shield Wallboard.
 - c. United States Gypsum Company; USG Sheetrock® Brand Mold Tough® Abuse-Resistant Firecode®.
2. Core: **5/8 inch (15.9 mm)**, Type X.
3. Surface Abrasion: Meets or exceeds Level 2 requirements.
4. Surface Indentation: Meets or exceeds Level 1 requirements.
5. Single-Drop Soft-Body Impact: Meets or exceeds Level 1 requirements.
6. Long Edges: Tapered.
7. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

D. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Georgia-Pacific Building Products; ToughRock Mold-Guard Gypsum Board.
 - b. National Gypsum Company; Gold Bond Brand XP Wallboard.
 - c. United States Gypsum Company; USG Sheetrock® Brand Mold Tough® Gypsum Panels.
2. Core: **5/8 inch (15.9 mm)**, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. Expansion (control) joint.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. **Hilti, Inc.;** CP 506 Smoke and Acoustical Sealant.
 - b. **Pecora Corporation;** AC-20 FTR.
 - c. **United States Gypsum Company;** SHEETROCK Acoustical Sealant.
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch (1.5 mm)** of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft. (0.7 sq. m)** in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch- (6.4- to 9.5-mm-)** wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide **1/4- to 1/2-inch- (6.4- to 12.7-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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: Vertical surfaces unless otherwise indicated.
 - 2. Flexible Type: Apply in double layer at curved assemblies.

3. Abuse-Resistant Type: Vertical surfaces in corridors less than 10 feet above finished floor, and as indicated on Drawings.
4. Impact-Resistant Type: As indicated on Drawings.
5. Mold-Resistant Type: As indicated on Drawings.
6. Type C: As indicated on Drawings.
7. Glass-Mat Interior Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, **16 inches (400 mm)** minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.6 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL 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. Section includes acoustical panels and exposed suspension systems for ceilings.

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. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
 - a. Armstrong (Basis-of-Design).
 - b. USG Interiors, Inc.
 - c. Certain Teed Corporation.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL PANELS GENERAL

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than **0.106-inch- (2.69-mm-)** diameter wire.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized-steel sheet complying with ASTM A 653/A 653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.
- F. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced **24 inches (610 mm)** o.c. on all cross tees.
- G. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard antimicrobial gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.5 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. [Armstrong World Industries, Inc.](#)
 2. [CertainTeed Corporation.](#)
 3. [United States Gypsum Company.](#)
- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than **G30 (Z90)** coating designation; with prefinished **15/16-inch- (24-mm-)** wide metal caps on flanges.
 1. Structural Classification: Intermediate-duty system.
 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 3. Face Design: Flat, flush.
 4. Cap Material: Steel cold-rolled sheet.
 5. Cap Finish: Painted white.

- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished 9/16-inch- (24-mm-) wide flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Tees: butt-edge type.
 - 3. Face Design: Dimensional.
 - 4. Finish: Painted White.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corporation.
 - 3. United States Gypsum Company.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
 - 1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
 - 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
 - 2. Concealed Joints: Nondrying, nonhardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant.

2.8 PRODUCTS

1. Acoustical Panel - Type ACT-1.
 - a. Type, Form and Finish: ASTM E1264, Type III, Form 2, Pattern CE.
 - b. Size: 24"x24"x 3/4"
 - c. CAC 35, NRC .70.
 - d. Edge Detail: Square.
 - e. Color: White.
 - f. Basis of Design: Armstrong Fine Fissured No. 1713.
2. Acoustical Panel - Type ACT-2
 - a. Type, Form and Finish: ASTM E1264, Type IV, Form 2, Pattern E.
 - b. Size: 24"x 24" x 3/4".
 - c. CAC 38, NRC .70.
 - d. Edge Detail: Square.
 - e. Color: White.
 - f. Basis of Design: Armstrong Ultima Health Zone No. 1935.
6. Direct-Hung Suspension Systems, Non-Fire-Resistance Rated:
 - a. At Acoustical Panel Types ACT-1 and ACT-2:
 - 1) Basis for Design: Armstrong Prelude XL grid.
 - 2) Type: Wide-face, capped double-web steel, hot-dipped galvanized, intermediate duty classification, ASTM C 636.
 - 3) Suspension System Accessories: Attachment devices and hangers, ASTM C 636.
 - 4) Color: White.
9. Acoustical-to-Drywall Transitions:
 - a. Where indicated, provide manufacturer's transition moldings.
 - 1) Basis for Design: Armstrong's Acoustical-to-Drywall Transition Moldings
 - 2) Type: No. 7902 – 15/16 inch Shadow Reveal Flush Acoustical-to-Drywall Transition Molding
10. Auxiliary Materials:
 - a. Hold-down clips and impact clips.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

- B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3.2 mm in 3.6 m)**. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 3. Install hold-down clips in all Vestibules, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 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 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 50 deg F or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 50 deg F or more than 95 deg F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 THERMOPLASTIC-RUBBER BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Johnsonite: a Tarkett company.
 - 3. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style B, Cove: Provide in areas with resilient flooring.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: 4 inches (102 mm).
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed.
- H. Colors: As selected by Architect from full range of industry colors.

2.3 RUBBER MOLDING ACCESSORY (TS)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Burke Mercer Flooring Products.
 - 3. Johnsonite.
 - 4. Roppe Corporation, USA.
- B. Description: Rubber reducer strip for resilient flooring and transition strips.
- C. Profile and Dimensions: Provide manufacturer's standard.
- D. Locations: Provide rubber molding accessories between all dissimilar floor finishes.
- E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.

- a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.

- a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.

3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096816 - 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 carpeting.
- B. Related Requirements:
 - 1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 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: 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: For carpet installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - 2. Carpet 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 Initial Selection: For each type of carpet.
 - 1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.
- D. Samples for Verification: 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. 18"x27" samples of each type of carpeting required.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- E. Product Schedule: For carpet. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replacement Materials: After completion of work, deliver not less than 5% of full width of carpet of each type, color, and pattern selected exclusive of material required to properly complete installation. Furnish accessory components; furnish one box each of replacement materials from same production run as materials installed. Package replacement materials with protective covering identified with appropriate labels.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.10 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.11 WARRANTY

- A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

0.1 GENERAL REQUIREMENTS

- . Carpet shall be first quality manufacture, the product of one manufacturer. No seconds or imperfects will be acceptable.
- A. Carpeting shall be permanently moth-proofed by the manufacturer and non-allergenic.
- B. Colors and patterns will be selected from the manufacturer's standard color samples. All carpeting of each color shall be from the same dye lot.

0.2 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - 0. Tandus (Basis of Design)
 - 3. Shaw Contract

4. Mohawk
5. Mannington
6. Patcraft

0.3 ACCEPTABLE PRODUCTS: Equivalent to the following specified as a basis-of-design.

A. CPT-1: Carpet Tile: 24" x 24" No. 04332 Stack 9 by Tandus.

- | | |
|------------------------------|--|
| 1. Construction | Pattern Loop |
| 2. Gauge | 5/64 |
| 3. Fiber System | Dynex ® Nylon |
| 4. Dye Method | 100% Solution Dyed |
| 5. Primary Tufting Substrate | Synthetic Non-Woven |
| 6. Colors | Selected by Architect from manufacturer's full range |

B. CPT-2: Carpet Tile Walk off Mat: 24" x 24" No. 02578 Abrasive Action II by Tandus.

- | | |
|--------------------------|--|
| 1. Construction | Accuweave ® Patterned Loop |
| 2. Gauge | 1/12 |
| 3. Stitches per Inch | 8.0 |
| 4. Pile Height Average | 0.187 inch |
| 5. Fiber System | TDX Nylon |
| 6. Dye Method | 100% Solution Dyed |
| 7. Soil/Stain Protection | Ensure |
| 8. Colors | Selected by Architect from manufacturer's full range |

2.1 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet, and are recommended by carpet manufacturer for releasable installation.
- C. Edge/Transition Strips: Refer to Section 096513 "Resilient Base and Accessories. Provide profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.
- B. Examine carpet for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet manufacturer's written installation instructions for preparing substrates indicated to receive carpet.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 15, "Attached Cushion Install" and with carpet manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet manufacturer.
- E. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- F. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer.

END OF SECTION 096816

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates. The following exterior substrates:
 - 1. Steel and iron.
 - 2. Galvanized metal.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. Dulux (formerly ICI Paints); a brand of AkzoNobel.
 - 3. Duron, Inc.
 - 4. Glidden Professional.
 - 5. PPG Architectural Coatings.
 - 6. Sherwin-Williams Company (The).
- B. Products: Subject to compliance with requirements, provide one of the products listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 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 CMUs): 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 Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and 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: 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-SP 2.

- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. 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.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.

- d. Pipe hangers and supports.
- e. Metal conduit.
- f. Plastic conduit.
- g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
 - 1. Water-Based Light Industrial Coating System:
 - a. Prime Coat: Primer, zinc rich, inorganic, MPI #19.
 - 1) PPG Metalhide One-Pac Inorganic Zinc Rich Primer 97-676.
 - 2) Sherwin-Williams; Zinc Clad XI B69V11/B69D11.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
 - 1) PPG; Pitt-Tech Plus Interior/Exterior Semi-Gloss DTM Industrial Enamel 90-1210.
 - 2) Sherwin-Williams; DTM Semi-Gloss B66W01151.
- B. Galvanized-Metal Substrates:
 - 1. Water-Based Light Industrial Coating System:

- a. Prime Coat: Light industrial coating, exterior, water based, matching topcoat.
- b. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
 - 1) PPG; Pitt-Tech Plus Interior/Exterior Semi-Gloss DTM Industrial Enamel 90-1210.
 - 2) Sherwin-Williams; DTM Semi-Gloss B66W01151.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel and iron.
 - 2. Galvanized metal.
 - 3. Wood.
 - 4. Gypsum board.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
 - 2. Section 133419 "Metal Building Systems"

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 2. Indicate VOC content.
- B. LEED Submittals: Comply with Section 018113.
1. MR Credit: BPDO – Material Ingredients
 - a. For paints and coatings, if available: Material Ingredient Report.
 2. EQ Credit: Low-Emitting Materials
 - a. For interior wet-applied paints and coatings: Documentation indicating compliance with California Department of Public Health (CDPH) Standard Method v1.1–2010 and VOC content in g/L.
- C. Samples for Initial Selection: For each type of topcoat product.
- D. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- 1.5 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.
- 1.6 QUALITY ASSURANCE
- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. Dulux (formerly ICI Paints); a brand of AkzoNobel.
 - 3. Duron, Inc.
 - 4. Glidden Professional.
 - 5. PPG Architectural Coatings.
 - 6. Sherwin-Williams Company (The).
- B. Products: Subject to compliance with requirements, provide one of the products listed in the Interior Painting Schedule for the paint category indicated. Products for each category shall be by a single manufacturer, unless otherwise noted.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Interior wet-applied paints and coatings: Comply with low-emitting requirements in Division 01 Section "Sustainable Design Requirements - LEED."
- D. Colors: As selected by Architect from manufacturer's full range, and as indicated in a color schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Masonry (Clay and CMUs): 12 percent.
 - 2. Wood: 15 percent.
 - 3. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. 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.
- E. Steel Substrates: 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-SP 2.
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- G. 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.
- H. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear, that does not have factory applied finish coating.
 - b. Backer boards (mask off and do not paint one label on each backer board showing that it is fire-retardant-treated).
 - c. Uninsulated metal piping.
 - d. Uninsulated plastic piping.
 - e. Pipe hangers and supports.
 - f. Metal conduit.
 - g. Plastic conduit.
 - h. Tanks that do not have factory-applied final finishes.
 - i. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces, black.

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 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Traffic Surfaces (“**CONC-2**”):
 1. Latex Floor Enamel System:
 - a. Prime Coat: Floor paint, latex, matching topcoat.
 - b. Topcoat: Floor paint, latex, low gloss (maximum MPI Gloss Level 5).
 - 1) PPG; Water-based Polyurethane Floor Enamel 247010.
 - 2) Sherwin-Williams; Armorseal Tread-Plex B90A101.

B. CMU Substrates:

1. Institutional Low-Odor/VOC Latex System MPI INT 4.2E (“**PT**”):
 - a. Block Filler: Two (2) coats Block filler, latex, interior/exterior, MPI #4.
 - 1) Benjamin Moore; Ultra Spec Interior/Exterior High-Build Masonry Block Filler 571/K571.
 - 2) PPG; Concrete Coatings Block Filler Interior/Exterior Primer 3010.
 - 3) Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W00025.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
 - 1) Benjamin Moore; Ultra Spec 500 Interior Low Sheen Finish N538/K538.
 - 2) PPG; Dulux Lifemaster Interior 100% Acrylic Latex Pearl 59425.
 - 3) Sherwin Williams; Harmony Interior Acrylic Latex Eg-Shel B09W01051.
2. Water-Based Light Industrial Coating System MPI INT 4.2K (“**EP**”):
 - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - 1) Benjamin Moore; Ultra Spec Interior/Exterior High-Build Masonry Block Filler 571/K571.
 - 2) PPG; Concrete Coatings Block Filler Interior/Exterior Primer 3010.
 - 3) Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W00025.
 - b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior, water based (MPI Gloss Level 3), MPI #151.
 - 1) Benjamin Moore; Pre-Catalyzed Epoxy Eggshell V342.
 - 2) PPG; Pitt-Tech Plus Interior/Exterior Satin DTM Industrial Enamel 90-1110.
 - 3) Sherwin-Williams; DTM Acrylic Eg-Shel B66W01251.

C. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System MPI INT 5.1S (“**PT**”):
 - a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - 1) Benjamin Moore; Ultra Spec HP Acrylic Metal Primer HP04/FP04.
 - 2) Sherwin-Williams; Pro-Cryl Universal Primer B66W310.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
 - 1) Benjamin Moore Ultra Spec 500 Waterborne Interior Gloos N540/K540.
 - 2) PPG Lifemaster No VOC Interior Acrylic Semi-Gloss 9200.
 - 3) Sherwin-Williams; Acrylic Semi-Gloss Coating B66W00651.
2. Water-Based Dry-Fall over Shop-Applied Quick-Drying Shop Primer System MPI INT 5.1CCC (“**PT**”):
 - a. Prime Coat: Primer, quick dry, for shop application, MPI #275.

- 1) Sherwin-Williams; Kem-Flash 500 Primer.
 - b. Topcoat: Dry fall, latex, flat, MPI #118.
 - 1) Benjamin Moore; Super Kote 5000 Dry Fall Acrylic Latex Flat N110.
 - 2) PPG; Latex Dryfall Flat 10111.
 - 3) Sherwin-Williams; Waterborne Acrylic Dryfall B42W00181.
 - c. Topcoat: Dry fall, latex (MPI Gloss Level 5), MPI #226.
 - 1) Benjamin Moore; Super Kote 5000 Dry Fall Acrylic Latex Semi-Gloss 112.
 - 2) PPG; Glidden Professional Waterborne Semi-Gloss Dryfall 1486.
 - 3) Sherwin-Williams; Waterborne Acrylic Dryfall Semi-Glass B42W83.
- D. Galvanized-Metal Substrates:
1. Institutional Low-Odor/VOC Latex System MPI INT 5.3N (“PT”):
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - 1) Benjamin Moore; Acrylic Metal Primer HP04/FP04.
 - 2) PPG; Metal Primer, Latex base for rust-free galvanized metal 635-045.
 - 3) Sherwin-Williams; Pro-Cryl Universal Primer B66W310.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
 - 1) Benjamin Moore Ultra Spec 500 Waterborne Interior Glos N540/K540.
 - 2) PPG Lifemaster No VOC Interior Acrylic Semi-Gloss 9200.
 - 3) Sherwin-Williams; Acrylic Semi-Gloss Coating B66W00651.
 2. Water-Based Dry-Fall System MPI INT 5.3H (“PT”):
 - a. Prime Coat: Dry fall, water based, for galvanized steel, matching topcoat.
 - b. Topcoat: Dry fall, water based, for galvanized steel, flat (MPI Gloss Level 1), MPI #133.
 - 1) Benjamin Moore; Super Kote 5000 Dry Fall Acrylic Latex Flat N110.
 - 2) PPG; Interior DTM Latex Dryfall Flat 10112.
 - 3) Sherwin-Williams; Waterborne Acrylic Dryfall B42W00181.
 - c. Topcoat: Dry fall, latex (MPI Gloss Level 5).
 - 1) Benjamin Moore; Super Kote 5000 Dry Fall Acrylic Latex Semi-Gloss 112.
 - 2) PPG; Glidden Professional Waterborne Semi-Gloss Dryfall 1486.
 - 3) Sherwin-Williams; Waterborne Acrylic Dryfall Semi-Gloss B42W83.
- E. Gypsum Board Substrates:
1. Institutional Low-Odor/VOC Latex System MPI INT 9.2M (“PT”):
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - 1) Benjamin Moore Ultra Spec 500 Waterborne Interior Primer N534/K534.
 - 2) PPG; Lifemaster No VOC Interior Primer 9116.

- 3) PPG; Speedhide Zero Interior Zero VOC Latex Sealer 6-4900XI.
- 4) Sherwin-Williams; Harmony Interior Latex Primer B11W01500.

- b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
- c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - 1) Benjamin Moore; Ultra Spec 500 Interior Flat Finish N536/K536.
 - 2) PPG; Speedhide Zero Interior Zero VOC Latex Flat Paint 6-4110XI.
 - 3) Sherwin-Williams; Harmony Interior Acrylic Latex Flat B05W01051.

- d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2/3), MPI #144 / #145.
 - 1) Benjamin Moore; Ultra Spec 500 Interior Eggshell N538/K538.
 - 2) PPG; Lifemaster No VOC Interior Eggshell Paint 9300.
 - 3) Sherwin-Williams; Harmony Interior Acrylic Latex Eg-Shel B09W01051.

- 2. Water-Based Light Industrial Coating System MPI INT 9.2L (“**EP**”):
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - 1) Benjamin Moore; Ultra Spec 500 Waterborne Interior Primer Sealer N534/K534.
 - 2) PPG; Speedhide Zero Interior Zero VOC Latex Sealer 6-4900XI.
 - 3) Sherwin-Williams; Harmony Interior Latex Primer B11W01500.

 - b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior, water based (MPI Gloss Level 3), MPI #151.
 - 1) Benjamin Moore; Pre-Catalyzed Epoxy Eggshell V342.
 - 2) PPG; Pitt-Tech Plus Interior/Exterior Satin DTM Industrial Enamel 90-1110.
 - 3) Sherwin-Williams; DTM Acrylic Eg-Shel B66W01251.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE EPOXY COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes surface preparation and application of high-performance coating systems on the following substrates:

- 1. Interior Substrates:

- a. Steel stairs, pipe and tube railings (typical).

- B. Related Sections include the following:

- 1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
- 2. Division 9 painting Sections for special-use coatings and general field painting.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.4 QUALITY ASSURANCE

- A. Master Painters Institute (MPI) Standards:

- 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
- 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and coating systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

- 1. Maintain containers in clean condition, free of foreign materials and residue.
- 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.

B. Colors: As selected by Architect from manufacturer's full range.

2.2 EPOXY COATINGS

A. Epoxy, Cold-Cured, Gloss: MPI #77.

1. Products: Subject to compliance with requirements, provide products by Sherwin-Williams Company or the equivalent products by one of the following:
 - a. Sherwin-Williams Company (The); Pro Industrial High Performance, (Basis-of-Design).
 - b. Benjamin Moore & Co.; Polyamide Epoxy Coating, CM36/CM37.
 - c. Columbia Paint & Coatings; Insl-x, Insl-Tile II, EP-5300.
 - d. Coronado Paint; Polyamide Epoxy Coating, 101 Line.
 - e. ICI Paints; Devoe/Fuller, Guardcote, DP34UXX.
 - f. Miller Paint; PPG Aquapon, Epoxy Cold Cured - Gloss, 95-1.
 - g. PPG Architectural Finishes, Inc.; Aquapon, Epoxy Cold Cured Gloss, 95-1.
 - h. Spectra-Tone; Insl-x, Insl-Tile II, EP5300 Series.
 - i. Tower Paint; Epoxy High Gloss Enamel, T8700.

B. Water-Based Epoxy (Interior and Exterior): MPI #115.

1. Products: Subject to compliance with requirements, provide products by Sherwin-Williams Company or the equivalent products by one of the following:
 - a. Sherwin-Williams Company (The); Industrial & Marine, Water Based Catalyzed Epoxy, B70W Series (Basis-of-Design).
 - b. Benjamin Moore & Co.; Acrylic Epoxy Gloss "A", Hardener "B", M43/M44.
 - c. Columbia Paint & Coatings; Dupont, Corlar Waterborne Acrylic Epoxy, 76P.
 - d. Coronado Paint; Water-Based Amine Adduct Epoxy, 142 Line.
 - e. General Paint, Ameron; Amercoat 335, 96 Line.
 - f. ICI Paints; Devoe Coatings, Tru Glaze WB Epoxy Coating, 4418.
 - g. Miller Paint; Waterborne Epoxy Gloss, 4300/4440.
 - h. PPG Architectural Finishes, Inc.; Aquapon, Waterborne Epoxy, 98-1/98-98.
 - i. Spectra-Tone; Insl-x Aqua-Tile W.B. Epoxy, ATA 100 Series.
 - j. Tower Paint, Sierra, Wall & Trim Enamel, S50.

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 work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
3. Coating application indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions.
 1. Use applicators and techniques suited for coating and substrate indicated.
 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.5 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Steel Substrates:

1. Pigmented Polyurethane over High-Build Epoxy System:
 - a. Prime Coat: Primer, epoxy, as recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
 - c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

END OF SECTION 099600

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - a. Visual display board assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
- B. Shop Drawings: For visual display units.
 - a. Include plans, elevations, sections, details, and attachment to other work.
 - b. Show locations of panel joints. Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.
 - c. Show locations and layout of special-purpose graphics.
 - d. Include sections of typical trim members.
- C. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:
 - a. Samples of facings for each visual display panel type, indicating color and texture.
 - b. Fabric swatches of fabric facings for tackboards.
 - c. Include accessory Samples to verify color selected.
- D. Samples for Verification: For each type of visual display unit indicated.
 - a. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
 - b. Trim: 6-inch- (150-mm-) long sections of each trim profile.
 - c. Display Rail: 6-inch- (150-mm-) long section of each type.
 - d. Accessories: Full-size Sample of each type of accessory.

- E. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.
- B. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels acceptable to manufacturer.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
 - a. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.8 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - a. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - b. Warranty Period: 50 years from date of Substantial Completion.
 - c. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Composite wood: Contain no added formaldehyde resins or comply with the California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM) for formaldehyde emissions for ultra-low-emitting formaldehyde (ULEF) resins.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 VISUAL DISPLAY BOARD ASSEMBLY (**MB**, **TB**)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide AARCO Products, Inc.; 420-series marker boards or a comparable product by one of the following:

- a. ADP Lemco.
b. Claridge Products and Equipment, Inc.
c. Platinum Visual Systems.
d. PolyVision Corporation.

- B. Visual Display Board Assembly: Factory fabricated.

- a. Assembly: Markerboard and tackboard.
b. Corners: Square.
c. Width: As indicated on Drawings.
d. Height: 4 feet, unless otherwise indicated on Drawings.
e. Mounting Method: Direct to wall.

- C. Markerboard Panel (**MB**): Porcelain-enamel-faced markerboard panel on core indicated.

- a. Aluminum frame and trim. Edge.
b. Color: White.
c. Accessories: Marker Tray

- D. Tackboard Panel (**TB**): Vinyl-fabric-faced tackboard panel on core indicated.

- a. Aluminum frame and trim. Edge.
b. Color and Pattern: As selected by Architect from full range of industry colors.
c. Accessories: Display rail, with accessories.

- E. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape.
 - a. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints.
 - b. Aluminum Finish: Clear anodic finish.
- F. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
- G. Marker tray: Manufacturer's standard; continuous.
 - a. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
- H. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, and continuous paper holder, designed to hold accessories.
 - a. Size: 1 inch (25 mm) to 2 inches (50 mm) high by full length of visual display unit.
 - b. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches (1200 mm) of display rail or fraction thereof.
 - c. Flag Holder: One for each room.
 - d. Tackboard Insert Color: As selected by Architect from full range of industry colors.
 - e. Aluminum Color: Match finish of visual display assembly trim.

2.4 MARKERBOARD PANELS

- A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with high-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
 - a. Face Sheet Thickness: 0.021 inch (0.53 mm) uncoated base metal thickness.
 - b. Particleboard Core: 1/2 inch (12.7 mm) thick minimum; with 0.005-inch- (0.127-mm-) thick, aluminum foil backing.
 - c. Medium-Density Fiberboard Core: 7/16 inch (11 mm) thick; with manufacturer's standard moisture-barrier backing.
 - d. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.5 TACKBOARD PANELS

- A. Tackboard Panels:
 - a. Facing: Vinyl fabric.
 - b. Core: Manufacturer's standard.

2.6 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.
- C. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
- D. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with surface-burning characteristics indicated.
- E. Hardboard: ANSI A135.4, tempered.
- F. Particleboard: ANSI A208.1, Grade M-1.
- G. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
- H. Fiberboard: ASTM C 208 cellulosic fiber insulating board.
- I. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- J. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.
- K. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
- L. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 099123 "Interior Painting" and recommended in writing by visual display unit manufacturer for intended substrate.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 - a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
 - b. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from

manufacturer's standard structural support accessories to suit conditions indicated.

- C. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than **16 inches (400 mm)** o.c. Secure tops and bottoms of boards to walls.
 - 1. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.
 - a. Mounting Height from finished floor to top of marker tray: As designated on drawings.
- D. Display Rails: Install rails at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than **16 inches (400 mm)** o.c.
 - a. Mounting Height: **40 inches (1016 mm)** and **80 inches (2032 mm)** above finished floor to top of rail.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 101100

SECTION 101416 - PLAQUES

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 plaques.
- B. Related Requirements:
 - 1. Section 101423 "Signage" for signs, with or without frames that are made of materials other than solid metal.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For plaques.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show plaque mounting heights, locations of supplementary supports to be provided by others, and accessories.
- C. Samples for Initial Selection: For each type of plaque, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of plaque showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Plaques: Sample of finished metal.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For plaques to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.
- B. Interior wet-applied adhesive: Comply with low-emitting requirements in Division 01 Section "Sustainable Design Requirements - LEED."

2.2 PLAQUES

- A. Cast Plaque: Plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.R.K. Ramos.
 - b. Metal Arts.
 - c. Southwell Company (The).
 2. Plaque Material: Cast bronze.
 3. Plaque Thickness: 0.25 inch (6.35 mm).
 4. Finishes:
 - a. Integral Metal Finish: As selected by Architect from full range of industry finishes.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.
 5. Background Texture: As selected by Architect from manufacturer's full range.
 6. Integrally Cast Border Style: Raised flat band, polished, with square corner accents with recessed circles.
 7. Mounting: Concealed studs.
 8. Text and Typeface: Typeface as selected by Architect from manufacturer's full range.
 9. Custom Graphics: Product custom graphics as required for plaque design, including conversion of graphics shown on plaque drawing to vector image.

2.3 MATERIALS

- A. Bronze Castings: ASTM B 584, alloy recommended by manufacturer and finisher for finish indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. Plaque Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of plaque, screwed into back of plaque, or screwed into tapped lugs cast integrally into back of plaque, unless otherwise indicated.
- B. Adhesive: As recommended by plaque manufacturer.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

- A. General: Provide manufacturer's standard plaques according to requirements indicated.
 - 1. Preassemble plaques in the shop to greatest extent possible. Disassemble plaques only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match plaque finish.
 - 6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Surface-Engraved Graphics: Machine engrave graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
 - 1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
- C. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted plaques to suit plaque construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 CLEAR ORGANIC COATING FOR COPPER-ALLOY FINISHES

- A. Clear Organic Coating: Clear, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of methyl methacrylate copolymer with benzotriazole to prevent breakdown of the film in UV light; shop applied in two uniform coats per manufacturer's written instructions, with interim drying between coats and without runs or other surface imperfections, to a total dry film thickness of **1 mil (0.025 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of plaque work.
- B. Verify that plaque-support surfaces are within tolerances to accommodate plaques without gaps or irregularities between backs of plaques and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install plaques using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
 - 2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of plaque. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed plaques and plaques that do not comply with specified requirements. Replace plaques with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as plaques are installed.
- C. On completion of installation, clean exposed surfaces of plaques according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain plaques in a clean condition during construction and protect from damage until acceptance by Owner.

3.4 PLAQUE SCHEDULE

- A. Plaque 1.
 - 1. Size: 18 inches wide by 24 inches high.
- B. Refer to attached exhibits for layout of plaques.

END OF SECTION 101416

DELAWARE TECHNICAL AND
COMMUNITY COLLEGE
AUTOMOTIVE CENTER OF EXCELLENCE
2020

(COLLEGE LOGO HERE)

Group.....

Name
Name
Name
Name
Name

Group.....

Name
Name
Name
Name
Name

Person

Name

Architect:
Contractor:

Becker Morgan Group, Inc.
To Be Determined

SECTION 101419 - 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.

1.3 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For dimensional letter 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, typestyles, graphic elements, and layout for each sign at least one-eighth size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Full-size Sample of each type of dimensional character.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.
- E. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.R.K. Ramos.
 - b. ACE Sign Systems, Inc.
 - c. ASI Sign Systems, Inc.
 - d. Gemini Incorporated.
 - e. Metal Arts.
 2. Character Material: Cast aluminum.
 3. Character Height: As designated on drawings.
 4. Thickness: Manufacturer's standard for size of character.
 5. Finishes:
 - a. Exterior: Baked-Enamel or Powder-Coat Finish: Custom color.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.
 6. Mounting: Projecting studs.
 7. Typeface: Match Delaware and Technical Community College font.

2.2 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

- B. Aluminum Extrusions: **ASTM B 221 (ASTM B 221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - 4. Sign Mounting Fasteners:
 - a. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace signs for stability and for securing fasteners.
 - 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 - 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.6 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 101423 - 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. Room-identification signs.

- B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
- 2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection-zone signage.
- 3. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
- 4. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
- 5. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
- 6. Section 265219 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings.

- 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, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least quarter size.

- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

- 1. Include representative Samples of available typestyles and graphic symbols.

- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Room-Identification Signs: Full-size Sample.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.
- E. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

2.2 SIGNS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 2/90 Sign Systems, Inc.
 - 2. APCO Graphics, Inc.
 - 3. ASI Sign Systems, Inc.
 - 4. Innerface Architectural Signage, Inc.
 - 5. Basis-of-Design: InPro Corporation (IPC); Apsen Collection.
 - 6. Mohawk Sign Systems.

- B. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Laminated-Sheet Sign: Sandblasted polymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign, but not less than **0.125 inch (3.18 mm)**.
 - b. Subsurface Graphics: Snap-in changeable insert beneath removable face sheet or slide-in changeable insert.
 - c. Color(s): As selected by Architect from manufacturer's full range.
 2. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Border with eased edge.
 - b. Corner Condition in Elevation: Rounded to radius indicated.
 3. Mounting: with two-face tape.
 4. Text and Typeface: Accessible raised characters and Braille typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.
- C. Plastic-Laminate Sheet: NEMA LD 3, general-purpose HGS grade, **0.048-inch (1.2-mm)** nominal thickness.
- D. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.
- E. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
 1. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
 2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
 3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
 4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- C. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.
 2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard.
- C. Mounting Methods:
 - 1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
- D. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

3.4 SIGN SCHEDULE

A. Room-Identification Signs

1. Size: As indicated on Drawings.
2. Locations: All doors except for the following:
 - a. Toilet rooms (refer to toilet room signs below).
 - b. Corridors and Vestibules.
 - c. Exterior doors (refer to exit signs below).
 - d. Equipment Platform door 114/1.
3. Changeable Message Capability: Provide changeable message capability at Classrooms 104 and 110, and at Offices 102 and 103.

B. Toilet Room Signs

1. Size: As indicated on Drawings.
2. Locations: All toilet rooms.

C. Exit Signs

1. Size: 6 inches wide by 4 inches high.
2. Message: "EXIT" in raised characters and type 2 braille.
3. Locations: All exterior exit doors having lighted exit signs.

END OF SECTION 101423

SECTION 102113.19 - PLASTIC 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. Section Includes:

- 1. Solid-plastic toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for blocking.
- 2. Section 102800 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

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 toilet compartments.

B. Shop Drawings: For toilet compartments.

- 1. Include plans, elevations, sections, details, and attachment details.
- 2. Show locations of centerlines of toilet fixtures.
- 3. Show locations of floor drains.
- 4. Show 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:

- 1. Each type of material, color, and finish required for toilet compartments, prepared on **6-inch-(152-mm-)** square Samples of same thickness and material indicated for Work.
- 2. Each type of hardware and accessory.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents and source.
1. Door Hinges: One hinge(s) with associated fasteners.
 2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
 3. Door Bumper: One bumper(s) with associated fasteners.
 4. Door Pull: One door pull(s) with associated fasteners.
 5. Fasteners: Ten fasteners of each size and type.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bradley Corporation.
 2. General Partitions Mfg. Corp.
 3. Global Partitions; ASI Group.
 4. Scranton Products.
 5. Yemm & Hart Green Materials.
- B. Toilet-Enclosure Style: Overhead braced.
- C. Urinal-Screen Style: Floor anchored.

- D. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
 - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
 - 2. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainless-steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
 - 3. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range.
- E. Pilaster Shoes: Manufacturer's standard design; stainless steel.
- F. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters; with shoe matching that on the pilaster.
- G. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
 - 1. Material: Clear-anodized aluminum or stainless steel.
 - a. Zamac is not acceptable material. Provide heavy-duty hardware as required.
 - 2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.
 - 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 - 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 - 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).

- C. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless-Steel Castings: ASTM A 743/A 743M.

2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at bottoms of posts. Provide shoes at posts to conceal anchorage.
- E. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch (13 mm).
 - b. Panels and Walls: 1 inch (25 mm).
 - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.

- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than **2 inches (51 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.19

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
- B. Related Requirements:
 - 1. Section 224000 "Plumbing Fixtures" for under lavatory guards and custodial accessories.

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.

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.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Samples: Full size, for each exposed product and for each finish specified.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Manufacturers: Subject to compliance with requirements, provide basis-of-design product, or comparable product by one of the following;
 - 1. AJW Architectural Products.
 - 2. Bobrick Washroom Equipment, Inc.
 - 3. Bradley Corporation.
- C. Toilet Tissue Dispenser (“A”): Provided by Owner but installed by Contractor.
- D. Paper Towel Dispenser (“N”): Provided by Owner but installed by Contractor.
- E. Liquid-Soap Dispenser (“B”): Provided by Owner but installed by Contractor.
- F. Grab Bar (“C”, “D”, and “E”):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; 5806.99x18, 5806.99x36, and 5806.99x42 or a comparable product by one of the following:
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

4. Outside Diameter: 1-1/4 inches (32 mm).
5. Configuration and Length: Straight, 18 inches (457 mm), 36 inches (914 mm), and 42 inches (1,067 mm) long.

G. Sanitary-Napkin Disposal Unit (“F”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-270 or a comparable product by one of the following:
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

H. Mirror Unit (“G”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-290-2436 and B-290-7236 or a comparable product by one of the following:
2. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick.
 - a. Corners: Welded and ground smooth.
3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
4. Size: As indicated on Drawings.

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard (“H”):

1. See Plumbing Fixture Specification.

2.4 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Mop and Broom Holder:

1. See Plumbing Fixture Specifications.

2.5 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with **G60 (Z180)** hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least **250 lbf (1112 N)**, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Fire-protection cabinets for fire extinguishers.
 - 3. Mounting brackets for fire extinguishers.
 - 4. Automatic electronic defibrillator (AED) and cabinet.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
 - 3. Show location of knockouts for hose valves.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.
- D. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 PORTABLE FIRE EXTINGUISHERS

- A. Manufacturers:
 - 1. Amerex Corporation.
 - 2. Ansul Incorporated.
 - 3. Badger Fire Protection.
 - 4. Buckeye Fire Equipment Company.
 - 5. Fire End & Croker Corporation.
 - 6. General Fire Extinguisher Corporation.
 - 7. JL Industries, Inc.
 - 8. Kidde Fyrnetics.
 - 9. Larsen's Manufacturing Company.
 - 10. Modern Metal Products; Div. of Technico.
 - 11. Moon American.
 - 12. Potter Roemer; Div. of Smith Industries, Inc.

13. Watrous; Div. of American Specialties, Inc.
- B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 1. Valves: Manufacturer's standard.
 2. Handles and Levers: Manufacturer's standard.
 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- C. Multipurpose Dry-Chemical Type in Steel Container Insert (Drawing designation: **FEC & FE**) - UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
 1. Basis of Design: JL Industries, Inc.: Cosmic 10E

2.4 FIRE-PROTECTION CABINET (**FEC**)

- A. Manufacturers:
 1. Fire End & Croker Corporation.
 2. General Accessory Mfg. Co.
 3. JL Industries, Inc.
 4. Kidde Fyrnetics.
 5. Larsen's Manufacturing Company.
 6. Modern Metal Products; Div. of Technico.
 7. Moon American.
 8. Potter Roemer; Div. of Smith Industries, Inc.
 9. Watrous; Div. of American Specialties, Inc.
- B. Cabinet Type: Basis of Design: JL Industries, Inc.: Cosmopolitan 1037 (semi-recessed).
- C. Cabinet Construction:
 1. FEC: Nonrated.
- D. Cabinet Material: Stainless-steel sheet.
- E. Semi-recessed Cabinet: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 1. Square-Edge Trim: 3-inch backbend depth.
- F. Surface-mounted Cabinet: Cabinet box mounted on surface of walls.
- G. Cabinet Trim Material: Same material and finish as door.
- H. Door Material: Stainless-steel sheet.
- I. Door Style: Fully glazed panel with frame.
- J. Door Glazing: Tempered float glass (clear).

- K. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting door pull and friction latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

- L. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
 - 3. Door Lock: Cylinder lock, keyed alike to other cabinets.
 - 4. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet glazing.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.

- M. Finishes:
 - 1. Manufacturer's standard Stainless Steel with #4 finish

2.5 MOUNTING BRACKETS (FE)

- A. Manufacturers:
 - 1. Amerex Corporation.
 - 2. Ansul Incorporated.
 - 3. Badger Fire Protection.
 - 4. Buckeye Fire Equipment Company.
 - 5. Fire End & Croker Corporation.
 - 6. General Fire Extinguisher Corporation.
 - 7. JL Industries, Inc.
 - 8. Larsen's Manufacturing Company.
 - 9. Potter Roemer; Div. of Smith Industries, Inc.

- B. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 1. Color: Red.

- C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

2.6 AUTOMATIC EXTERNAL DEFIBRILLATOR AND CABINET (AED)

- A. Basis-of-Design: Subject to compliance with requirements, provide the following:
1. Automatic External Defibrillator: Defibtech, LLC; Lifeline AED.
 2. Cabinet: JL Industries, Inc., Metal AED Cabinet #1413.
 3. Product substitutions shall be made during the bidding period according to the requirements specified in "Material and Equipment."
- B. Mounting: Surface Mounted.
- C. Accessories: Provide manufacturer's standard battery pack with standby life of not less than seven years, two sets of defibrillation pads, emergency instruction card, and all other equipment required for proper use and maintenance.

2.7 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
 2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.
 - a. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish fire-protection cabinets after assembly.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
- C. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire-protection cabinets.
 - 1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- D. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- E. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104400

SECTION 105301 - PREFABRICATED HANGER ROD CANOPIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes design, fabrication and installation of complete, extruded aluminum hanger rod canopies. All work shall be in accordance with the drawings and this specification.
 - 1. Manufacturer's standard building components and accessories may be used, provided components, accessories, and complete structure conform to design indicated and specified requirements.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Flashing and sheet metal are specified in Division 7 Section "Flashing and Sheet Metal"
 - 2. Sealants and caulking are specified in Division 7 Section "Joint Sealants."
 - 3. Electrical lighting as specified in Division 26.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Engineer, design, fabricate and erect the pre-engineered building system to withstand loads from winds, gravity, structural movement including movement thermally induced, and to resist in-service use conditions that the building will experience, including exposure to the weather, without failure. Coordinate electrical requirements for mounting of lights and electrical supply.
- B. Submittals:
 - 1. Product Data: Submit manufacturer's product information, specifications and installation instructions for building components and accessories.
 - 2. Shop Drawings: Submit complete shop drawings including all necessary plan dimensions, elevations and details. General Contractor shall verify all dimensions and provide elevations at each column, finish floor, and related soffit before releasing to manufacturer for fabrication.
 - 3. Certification: Submit design calculations signed and sealed by a Registered Professional Engineer. Design calculations shall state that the protective cover system design complies with the wind requirements of ANSI/ASCE 7-88, the stability criteria of applicable building code, and all other governing criteria. Engineer to be registered in state where project is located.
- C. Quality Assurance:
 - 1. Protective cover shall be wholly produced by a recognized manufacturer with at least **10** years experience in the design and fabrication of extruded aluminum protective cover system. Components shall be installed by manufacturer. Protective cover system, including material and workmanship, shall be warranted from defects for a period of one year from substantial completion.

PART 2- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS.

- A. General Performance: Work shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Loading: As shown on drawings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.1 AVAILABLE MANUFACTURERS

- A. Basis-of-Design product: Subject to compliance with requirements, provide products by Peachtree Protective Covers (770) 424-6600 or a comparable product by one of the following:
 - 1. Dittmer Architectural Aluminum.
 - 2. Avadek Walkway Cover Systems.
 - 3. E.L. Burns Company.

2.2 DESIGN

- A. Protective cover shall be all welded extruded aluminum system complete with internal drainage. Roll formed deck is not acceptable. Expansion joints shall be included to accommodate temperature changes of 120BF.

2.3 MATERIALS

- A. Aluminum Members: All sections shall be extended aluminum 6063 alloy, Heat treated to a T-6 Temper.
- B. Fasteners: Fasteners shall be aluminum, 18-8 stainless steel, 300 series stainless steel, or 410 stainless steel.
- C. Protective coating: Aluminum columns embedded in concrete shall be protected by clear acrylic.
- D. Grout: Grout shall be 2,000 psi compressive strength. One part Portland cement and three parts masonry sand. Add water to produce pouring consistency.
- E. Gaskets: Gaskets shall be dry seal santoprene pressure type.

2.4 COMPONENTS

- A. Beams: Beams shall be open-top tubular extrusion of size and shape shown on drawings, top edges thickened for strength and designed to receive deck members in self-flashing manner. Extruded structural ties shall be installed in tops of all beams.
- B. Deck: Deck shall be extruded self-flashing sections interlocking into composite unit with sufficient chamber to offset dead load deflection and cause positive drainage. Plates shall be used as closures at deck ends.
- C. Fascia: Fascia shall be manufacturer's standard shape. Size as indicated on drawings.

- D. Flashing: Flashing shall be .040 aluminum (min.). All thru-wall flashing by others.

2.5 FABRICATION

- A. Bent Construction: Beams and columns shall be factory-manufactured with neatly mitered corners onto one-piece rigid bents. All welds shall be smooth and uniform using an inert gas shielded arc. Suitable edge preparation shall be performed to assure 100% penetration. Grind welds only where interfering with adjoining structure to allow for flush connection. Field welding is not permitted. Rigid mechanical joints shall be used shipping limitations prohibit the shipment of fully welded bents.
- B. Deck Construction: Deck shall be manufactured of extruded modules that interlock in self-flashing manner. Interlocking joints shall be positively fastened at 800.C. creating a monolithic structural unit capable for developing the full strength of the sections. The fastenings must have minimum shear strength of 350 pounds each. Deck shall be assembled with sufficient camber to offset dead load deflection.

2.6 FINISHES

- A. General: Comply with NAAMM "metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish designations prefixed by "AA" conform to the system established by the Aluminum, Association for designating aluminum finishes.
- C. Baked enamel finish, custom colors.
 - 1. Color: Custom.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Erection shall be performed after all masonry and roofing work in the vicinity is complete and cleaned.
- B. General Contractor shall verify and approve dimensions and elevations shown on shop drawings with actual field dimensions to verify conditions are satisfactory for installation.

3.2 INSTALLATION

- A. Column Sleeves: Column sleeves (styrofoam blockouts) or anchor bolts (if required) shall be furnished by the protective manufacturer and installed by General Contractor.
- B. Erection: Protective cover shall be erected true to line, level and plumb. Aluminum columns embedded in concrete shall be filled with grout to the discharge level to prevent standing water. Non-draining columns shall have weep holes installed at top of concrete to remove condensation.
- C. Coordination: Coordinate installation with other trades as necessary for a complete and operable installation.

3.3 CLEANING

- A. All protective cover components shall be cleaned promptly after completion of installation.

3.4 PROTECTION

- A. Extreme care shall be taken to protect materials during and after installation.

END OF SECTION 105301

SECTION 105614 - METAL STORAGE SHELVING AND 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. Four-post metal storage shelving.
 - 2. Metal storage cabinets.

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 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.
- B. Shop Drawings: For customized metal storage shelving.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include installation details of connectors, lateral bracing, and special bracing.
- C. Samples for Initial Selection: For units with factory-applied color finishes. Include similar Samples of accessories involving color selection.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shelves: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than five shelves.
2. Shelf-to-Post Connectors: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 connectors.
3. Shelf-Label Holders: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 holders.

1.7 SITE CONDITIONS

- A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels acceptable to manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance for Four-Post Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.1.

2.2 FOUR-POST METAL STORAGE SHELVING (MS-#)

- A. Open Four-Post Metal Storage Shelving: Factory-formed, field-assembled, freestanding system, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units as add-on units, designed to share two corner posts with initial shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Borroughs Corporation; Box Edge Plus.
 - b. EQUIPTO; Iron Grip.
 - c. Penco Products, Inc.; Clipper Industrial Shelving.
 - d. Tennsco; Q-Line.
 - e. Global Industrial.
2. Load-Carrying Capacity per Shelf: 400 lb (181 kg).
3. Posts: Fabricated from hot-rolled steel; in manufacturer's standard shape; with perforations at 1-1/2 inches (38 mm) o.c. to receive shelf-to-post connectors.
 - a. Steel Thickness, Nominal: As required for load-carrying capacity per shelf and number of shelves, 0.075 inch (1.90 mm) minimum.
 - b. Add-On Shelf Posts: Fabricated from hot-rolled steel, manufacturer's standard shape; perforated to match main posts and of same thickness.
 - c. Post Base: Bolt leveler.
4. Bracing: Manufacturer's standard, single or double diagonal cross bracing at back and ends; as required for stability, load-carrying capacity of shelves, and number of shelves.
5. Solid-Type Shelves: Fabricated from steel sheet as follows:

- a. Steel Sheet Thickness, Nominal: As required for load-carrying capacity per shelf, **0.036 inch (0.91 mm)** minimum.
 - b. Fabricate fronts and backs of shelves with box-formed edges, with corners lapped and welded.
 - c. Where required for load capacity, fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel bars or channels.
6. Shelf Quantity: Four shelves per shelving unit in addition to top and bottom shelf.
 7. Shelf-to-Post Connectors: Manufacturer's standard connectors.
 8. Base: Open, with exposed post legs.
 9. Overall Unit Width and Height:
 - a. MS-1: 48 inches (1219 mm) wide by 24 inches (610 mm) deep.
 - b. MS-2: 36 inches (914 mm) wide by 24 inches (610 mm) deep.
 - c. MS-3: 48 inches (1219 mm) wide by 18 inches (457 mm) deep.
 - d. MS-4: 36 inches (914 mm) wide by 18 inches (457 mm) deep.
 - e. MS-5: 36 inches (914 mm) wide by 12 inches (305 mm) deep.
 10. Overall Unit Height: 84 inches (2134 mm).
 11. Accessories:
 - a. Shelf-Label Holders: Clear plastic, designed to clip onto front edge of shelf.
 12. Steel Finish: Baked enamel or powder coat.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.3 METAL STORAGE CABINETS

- A. Metal Storage Cabinets: Factory-formed, field-assembled, freestanding system, designed with shelves adjustable over the inner height of unit, and reinforced lockable doors.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Borroughs Corporation.
 - b. EQUIPTO.
 - c. Penco Products, Inc.
 - d. Tennsco;.
 - e. Global Industrial.
 2. Load-Carrying Capacity per Shelf: **300 lb (136 kg)**.
 - a. Steel Thickness, Nominal: As required for load-carrying capacity per shelf and number of shelves, **0.075 inch (1.90 mm)** minimum.
 3. Solid-Type Shelves: Fabricated from steel sheet as follows:
 - a. Steel Sheet Thickness, Nominal: As required for load-carrying capacity per shelf, **0.036 inch (0.91 mm)** minimum.
 - b. Fabricate fronts and backs of shelves with box-formed edges, with corners lapped and welded.
 - c. Where required for load capacity, fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel bars or channels.
 4. Shelf Quantity: Four adjustable shelves per unit in addition to top and bottom.

5. Base: Closed.
6. Overall Unit Width and Height:
 - a. MC-1: 36 inches (914 mm) wide by 24 inches (610 mm) deep.
7. Overall Unit Height: 78 inches (1981 mm).
8. Accessories:
 - a. Shelf-Label Holders: Clear plastic, designed to clip onto front edge of shelf.
9. Steel Finish: Baked enamel or powder coat.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.4 MATERIALS

- A. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating.
- D. Steel Tubing: ASTM A 513/A 513M, Type 2.
- E. Particleboard: ANSI A208.1.
- F. Hardboard: ANSI A135.4.
- G. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide two per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.5 FABRICATION

- A. Shop Fabrication: Prefabricate shelving components in shop to greatest extent possible to minimize field fabrication; temporarily preassemble shelving components where necessary to ensure that field-assembled components fit together properly. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate metal storage shelving square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
 1. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
 2. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 3. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
 4. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.
- C. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

- D. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a **1/2-inch- (13-mm-)** wide hem on the concealed side; ease edges of metal plate to radius of approximately **1/32 inch (0.8 mm)**. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 METALLIC-COATED STEEL SHEET FINISHES

- A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780/A780M.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

2.8 STEEL FINISHES

- A. Surface Preparation: 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."
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine floors for suitable conditions where metal storage shelving will be installed.

- C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Vacuum finished floor and wet mop resilient flooring over which metal storage shelving is to be installed.

3.3 INSTALLATION

- A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
 - 1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
 - 3. Adjust post-base bolt leveler to achieve level and plumb installation.
 - 4. Connect side-to-side shelving units together.
 - 5. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.
 - a. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.
- B. Accessories:
 - 1. Shelf-Label Holders: Install one on each shelf, centered within each shelving unit.

3.4 ERECTION TOLERANCES

- A. Erect four-post metal storage shelving to a maximum tolerance from vertical of **1/2 inch (13 mm)** in up to **10 feet (3 m)** of height, not exceeding **1 inch (25 mm)** for heights taller than **10 feet (3 m)**.

3.5 ADJUSTING

- A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.
- B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
- C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- D. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

SECTION 122413 - 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.

B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

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 for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples for Initial Selection: For each type and color of shadeband material.

- 1. Include Samples of accessories involving color selection.

D. Samples for Verification: For each type of roller shade.

- 1. Shadeband Material: Not less than 10 inches (250 mm) square. Mark inside face of material if applicable.
- 2. Roller Shade: Full-size operating unit, not less than 16 inches (400 mm) wide by 36 inches (900 mm) long for each type of roller shade indicated.
- 3. Installation Accessories: Full-size unit, not less than 10 inches (250 mm) long

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material, signed by product manufacturer.

- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by MechoShade Systems, Inc. or a comparable product by one of the following:
 - 1. Draper Inc.; Single Roller Clutch Operated FlexShade
 - 2. Hunter Douglas Contract; FR Roller Shades (if mounting can meet MechoShade dimensions).
 - 3. Lutron Electronics Co., Inc.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Nickel-plated metal or stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: Right side of inside face of shade.
 - 2. Direction of Shadeband Roll: Regular, from back of roller.
 - 3. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
 - 1. Shadeband Material:
 - a. Light-filtering fabric: Unless otherwise indicated.
 - b. Opaque: At windows at Nurse A16.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- F. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than **3 inches (76 mm)**.
2. Endcap Covers: To cover exposed endcaps.
3. Installation Accessories Color and Finish: Black.

2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Roller-shade manufacturer.
 2. Type: Woven polyester and PVC-coated polyester.
 3. Weave: Twill.
 4. Openness Factor: 3 percent.
 5. Color: Basis-of-Design Mechoshade ThermoVeil Dense Basket Weave 1500 Series, Color: 1513 Grey.
 - a. Orient material with dark color toward room.

2.4 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at **74 deg F (23 deg C)**:
 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less **1/4 inch (6 mm)** per side or **1/2-inch (13-mm)** total, plus or minus **1/8 inch (3.1 mm)**. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less **1/4 inch (6 mm)**, plus or minus **1/8 inch (3.1 mm)**.
 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 ROLLER WINDOW SHADE SCHEDULE

- A. Manually-Operated Shades: Provide at the following locations:
 - 1. At exterior storefront frames (designated as SF) in Office 102 and Office 103.

END OF SECTION 122413

SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-FACED CASEWORK

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 plastic-laminate-faced cabinets of stock design.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring casework.
 - 2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
 - 3. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-faced casework.
 - 4. Section 123661 "Solid Surfacing Countertops and Sills".

1.3 DEFINITIONS

- A. Definitions in the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" apply to the work of this Section.
- B. MDF: Medium-density fiberboard.
- C. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive, and faced both front and back with hardwood veneers.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.

1.5 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show fabrication details, including types and locations of hardware. Show installation details, including field joints and filler panels. Indicate manufacturer's catalog numbers for casework.
- C. Keying Schedule: Include schematic keying diagram and index each key set to unique designations that are coordinated with the Contract Documents.
- D. Samples for Initial Selection: For cabinet finishes.
- E. Samples for Verification: **8-by-10-inch (200-by-250-mm)** Samples for each type of finish.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
 - 1. AWI QCP Project Number: 16.0419.
- C. Sample Warranty: For special warranty.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation of units required for this Project and who is a certified participant in AWI's Quality Certification Program.
- B. Forest Certification: Provide wood products made from forests certified by an FSC-accredited certification body. All non-FSC wood in assemblies with FSC-certified wood shall meet the FSC Controlled Wood (CW) criteria.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Maintain temperature and relative

humidity during the remainder of the construction period in range recommended for Project location by the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Case Systems Inc.
 - 2. LSI Corporation of America.
 - 3. Stevens Industries, Inc.
 - 4. Thermo Fisher Scientific, Inc.
 - 5. TMI Systems Design Corporation.
- B. Source Limitations: Obtain plastic-laminate-faced cabinets from single manufacturer.

2.2 CASEWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: Custom.
 - 2. Provide labels and certificates from AWI certification program indicating that casework, including installation, complies with requirements of grades specified.
- B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-faced cabinets by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

- C. Product Designations: Drawings indicate configurations of manufactured plastic-laminate-faced cabinets by referencing designations of Casework Design Series numbering system in Appendix A of the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

2.3 CASEWORK

A. Design:

- 1. Flush overlay.

B. Grain Direction for Wood Grain Plastic Laminate:

- 1. Vertical on both doors and drawer fronts, with continuous vertical matching.
- 2. Vertical on doors, horizontal on drawer fronts.
- 3. Lengthwise on face frame members.
- 4. Vertical on end panels.
- 5. Side to side on bottoms and tops of units.
- 6. Vertical on knee-space panels.
- 7. Horizontal on aprons.

C. Exposed Materials:

- 1. Plastic Laminate: Grade HGS.
 - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
- 2. Unless otherwise indicated, provide specified edgebanding on all exposed edges.
- 3. Solid Wood: Clear hardwood lumber of species indicated, selected for compatible grain and color.
- 4. Wood Species: White maple.

D. Semiexposed Materials:

- 1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
 - a. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
- 2. Thermoset Decorative Panels: Provide thermoset decorative panels for semiexposed surfaces unless otherwise indicated.
 - a. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
- 3. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
- 4. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

E. Concealed Materials:

- 1. Solid Wood: Any hardwood or softwood species, with no defects affecting strength or utility.
- 2. Plywood: Hardwood plywood.
- 3. Plastic Laminate: Grade BKL.
- 4. Particleboard.

5. MDF.

2.4 MATERIALS

- A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.
- C. Softwood Plywood: DOC PS 1.
- D. Particleboard: ANSI A208.1, Grade M-2.
- E. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density.
- F. MDF: ANSI A208.2, Grade 130.
- G. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation.
 - b. Nevamar; a Panolam Industries International, Inc. brand.
 - c. Pionite Surface Systems.
 - d. Wilsonart.
- H. Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3 mm thick at doors and drawer fronts, 1 mm thick elsewhere.
- I. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
- J. Edgebanding for Thermoset Decorative Panels: PVC or polyester edgebanding matching thermoset decorative panels.
- K. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.5 COLORS AND FINISHES

- A. Wood Colors and Finishes: As selected by Architect from casework manufacturer's full range.
- B. Thermoset Decorative Panel Colors, Patterns, and Finishes: As selected by Architect from thermoset decorative panel manufacturer's full range.
- C. Plastic-Laminate Colors, Patterns, and Finishes: As selected by Architect from manufacturer's full range.
- D. PVC Edgebanding Color: As selected from casework manufacturer's full range.

2.6 FABRICATION

- A. Plastic-Laminate-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:
1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: **3/4-inch (19-mm)** particleboard.
 2. Shelves: **3/4-inch- (19-mm-)** thick plywood or **1-inch- (25-mm-)** thick particleboard.
 3. Backs of Cabinets: **1/2-inch- (12.7-mm-)** thick particleboard or MDF where exposed, dadoed into sides, bottoms, and tops where not exposed.
 4. Drawer Fronts: **3/4-inch (19-mm)** particleboard.
 5. Drawer Sides and Backs: **1/2-inch (12.7-mm)** particleboard or MDF, with glued dovetail or multiple-dowel joints.
 6. Drawer Bottoms: **1/4-inch (6.4-mm)** hardwood plywood glued and dadoed into front, back, and sides of drawers. Use **1/2-inch (12.7-mm)** material for drawers more than **24 inches (600 mm)** wide.
 7. Doors **48 Inches (1200 mm)** High or Less: **3/4 inch (19 mm)** thick, with particleboard or MDF cores and solid-wood stiles and rails.
 8. Doors More Than **48 Inches (1200 mm)** High: **1-1/16 inches (27 mm)** thick, with honeycomb cores and solid hardwood stiles and rails.
 9. Stiles and Rails of Glazed Doors **48 Inches (1200 mm)** High or Less: **3/4 inch (19 mm)** thick, with particleboard cores.
 10. Stiles and Rails of Glazed Doors More Than **48 Inches (1200 mm)** High: **1-1/16-inch- (27-mm-)** thick, with solid wood cores.
- B. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets.

2.7 CASEWORK HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.
- B. Butt Hinges: Stainless-steel, semiconcealed, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than **48 inches (1220 mm)** high, and provide three hinges for doors more than **48 inches (1220 mm)** high.
- C. Frameless Concealed Hinges (European Type): BHMA A156.9, Type B01602, 135 degrees of opening. Provide two hinges for doors less than **48 inches (1220 mm)** high, and provide three hinges for doors more than **48 inches (1220 mm)** high.
- D. Pulls: Solid stainless-steel wire pulls, fastened from back with two screws. For sliding doors, provide recessed stainless-steel flush pulls. Provide two pulls for drawers more than **24 inches (600 mm)** wide.
- E. Door Catches: Powder-coated, nylon-roller spring catch or dual, self-aligning, permanent magnet catch. Provide two catches on doors more than **48 inches (1220 mm)** high.
- F. Drawer Slides: BHMA A156.9, Type B05091.
1. Standard Duty (Grades 1, 2, and 3): Side mounted and extending under bottom edge of drawer; full-extension type; epoxy-coated steel with polymer rollers.

2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated, steel ball-bearing slides.
- G. Label Holders: Stainless steel, sized to receive standard label cards approximately 1 by 2 inches (25 by 51 mm), attached with screws or brads.
1. Provide label holders where indicated, and at each mailbox slot at Mail Room.
- H. Drawer and Hinged Door Locks: Cylindrical (cam) type, five-pin tumbler, brass with chrome-plated finish, and complying with BHMA A156.11, Grade 1.
1. Provide a minimum of two keys per lock and six master keys.
 2. Provide locks on all doors and drawers.
- I. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door units.
- J. Adjustable Shelf Supports: Two-pin locking plastic shelf rests complying with BHMA A156.9, Type B04013.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CASEWORK INSTALLATION

- A. Grade: Install cabinets to comply with same grade as item to be installed.
- B. Install casework level, plumb, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch (1.5 mm) of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm). Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch (1.5 mm) of a single plane. Fasten to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch (1.5 mm).
- E. Fasten cabinets to adjacent cabinets and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

- G. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216

SECTION 123661 - SOLID SURFACING COUNTERTOPS AND SILLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.
 - 3. Solid surface material end splashes.
 - 4. Solid surface material apron fronts.
 - 5. Solid surface sills.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches (150 mm) square.
 - 2. One full-size solid surface material countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 SOLID SURFACE MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **E. I. du Pont de Nemours and Company.**
 - b. **LG Chemical, Ltd.**
 - c. **Meganite Inc.**
 - 2. Type: Provide Standard type unless Special Purpose type is indicated.
 - 3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
 - 4. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Particleboard: ANSI A208.1, Grade M-2 and Grade M-2-Exterior Glue.
- C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.3 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:

1. Front:
 - a. Typical, unless otherwise noted: 1-inch (25-mm) laminated bullnose.
 - b. At millwork at Waiting A01, Clerical A03, and Waiting A26: 1-1/2-inch (38-mm) laminated bullnose.
 - c. At Men A32 and Women A34: 1-1/2-inch (38-mm) laminated bullnose with apron, 2 inches (50 mm) high.
 2. Backsplash: Straight, slightly eased at corner.
 3. End Splash: Matching backsplash.
- C. Countertops and sills: 1/2-inch- (12.7-mm-) thick, solid surface material with front edge built up with same material.
- D. Backsplashes: 1/2-inch- (12.7-mm-) thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
1. Fabricate with loose backsplashes for field assembly.
 2. Install integral sink bowls in countertops in the shop.
- F. Joints: Fabricate countertops without joints.
- G. Joints: Fabricate countertops in sections for joining in field only where lengths exceed what can be shop-fabricated and delivered to jobsite, with joints at locations indicated in shop drawings.
1. Joint Locations: Not within 18 inches (450 mm) of a sink or cooktop and not where a countertop section less than 36 inches (900 mm) long would result, unless unavoidable.
 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- 2.4 INSTALLATION MATERIALS
- A. Adhesive: Product recommended by solid surface material manufacturer.
 - B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of **1/8 inch in 8 feet (3 mm in 2.4 m)**, **1/4 inch (6 mm)** maximum. Do not exceed **1/64-inch (0.4-mm)** difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Pre-drill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 133419 - METAL BUILDING 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. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Foamed-insulation-core metal wall panels.
5. Metal soffit panels.
6. Thermal insulation.
7. Personnel doors and frames.
8. Accessories.

B. Related Requirements:

1. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface.
2. Section 083613 "Sectional Doors" for sectional vehicular doors located in the metal building system.
3. Section 084113 "Aluminum Entrances and Storefronts" for aluminum entrances and storefronts located in the metal building system.
4. Sections 087000 and 087101 for door hardware.
5. Section 012300 "Alternates" for roof panel alternate.

1.3 DEFINITIONS

- A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.4 COORDINATION

- A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

- B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to metal building systems including, but not limited to, the following:
 - a. Condition of foundations and other preparatory work performed by other trades.
 - b. Structural load limitations.
 - c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
 - d. Required tests, inspections, and certifications.
 - e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.
 - 2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:
 - a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
 - b. Structural limitations of purlins and rafters during and after roofing.
 - c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 - d. Temporary protection requirements for metal roof panel assembly during and after installation.
 - e. Roof observation and repair after metal roof panel installation.
 - 3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
 - a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
 - b. Structural limitations of girts and columns during and after wall panel installation.
 - c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 - d. Temporary protection requirements for metal wall panel assembly during and after installation.
 - e. Wall observation and repair after metal wall panel installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of metal building system component.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

- a. Foamed-insulation-core metal roof panels.
 - b. Foamed-insulation-core metal wall panels.
 - c. Metal soffit panels.
 - d. Thermal insulation and vapor-retarder facings.
 - e. Personnel doors and frames.
 - f. Windows.
 - g. Roof ventilators.
 - h. Louvers.
- B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:
1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
 2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
 - a. Show provisions for attaching mezzanines and pipe racks.
 3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
 - a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
 - b. Show wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
 4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:8):
 - a. Flashing and trim.
 - b. Gutters.
 - c. Downspouts.
- C. Samples for Initial Selection: For units with factory-applied finishes.
- D. Samples for Verification: For the following products:
1. Panels: Nominal 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
 2. Flashing and Trim: Nominal 12 inches (300 mm) long. Include fasteners and other exposed accessories.
 3. Vapor-Retarder Facings: Nominal 6-inch- (150-mm-) square Samples.
 4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
 5. Accessories: Nominal 12-inch- (300-mm-) long Samples for each type of accessory.

- E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.
 - 1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - 2. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.
- F. Delegated-Design Submittal: For metal building systems.
 - 1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:
 - 1. Name and location of Project.
 - 2. Order number.
 - 3. Name of manufacturer.
 - 4. Name of Contractor.
 - 5. Building dimensions including width, length, height, and roof slope.
 - 6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
 - 7. Governing building code and year of edition.
 - 8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
 - 9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
 - 10. Building-Use Category: Indicate category of building use and its effect on load importance factors.
- C. Erector Certificates: For qualified erector, from manufacturer.
- D. Material Test Reports: For each of the following products:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shop primers.
 - 5. Nonshrink grout.
- E. Source quality-control reports.

- F. Field quality-control reports.
- G. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.
- H. Sample Warranties: For special warranties.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer.
 - 1. Accreditation: Manufacturer's facility accredited according to the International Accreditation Service's AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
 - 2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.
- B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
- D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Build mockups for typical wall metal panel including accessories.
 - a. Size: 48 inches (1200 mm) long by 48 inches (1200 mm) minimum.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect foam-plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 - 3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.12 WARRANTY

- A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Nucor Building Systems or comparable product by one of the following:
1. Butler Manufacturing Company; a division of BlueScope Buildings North America, Inc.
 2. Nucor Building Systems.
 3. Star Building Systems; a division of NCI Building Systems, Inc.
 4. Varco-Pruden Buildings; a division of BlueScope Buildings North America, Inc
- B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

- A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.
- B. Primary-Frame Type:
1. Rigid Modular: Solid-member, structural-framing system with interior columns.
- C. End-Wall Framing: Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.
- D. Secondary-Frame Type: Manufacturer's standard purlins and joists and girts.
- E. Eave Height: As indicated by nominal height on Drawings.
- F. Bay Spacing: As indicated on Drawings.
- G. Roof Slope: 2 inches per 12 inches (1:3).
- H. Base bid Roof System: Equivalent to Nucor's Classic Standing Seam SR2 Insulated Roof Panel.
- I. Deduct Alternate Roof System; Equivalent to Nucor's Classic Roof Panel.
1. Liner Panels: Tapered rib.
- J. Exterior Wall System: Manufacturer's standard concealed-fastener foamed-insulation-core metal wall panels.
1. Liner Panels: Flush profile.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.
- B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
 - 1. Design Loads: As indicated on Drawings.
 - 2. Deflection and Drift Limits: Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."
 - 3. Deflection and Drift Limits: No greater than the following:
 - a. Purlins and Rafters: Vertical deflection of 1/240 of the span.
 - b. Girts: Horizontal deflection of 1/240 of the span.
 - c. Metal Roof Panels: Vertical deflection of 1/240 of the span.
 - d. Metal Wall Panels: Horizontal deflection of 1/240 of the span.
 - e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
 - f. Lateral Drift: Maximum of 1/50 of the building height.
- C. Seismic Performance: Metal building system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory," FM Global's "Approval Guide," or from the listings of another qualified testing agency.
- F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.
- G. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
- H. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 1. Wind Loads: As indicated on Drawings.
- I. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- J. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- K. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- L. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 1. Uplift Rating: UL 90.
- N. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 1. Fire/Windstorm Classification: Class 1A-120.
 2. Hail Resistance: SH.
- O. Energy Star Listing: Roof panels that are listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
- P. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
 1. Three-year, aged, solar reflectance of not less than 0.55 and emissivity of not less than 0.75.

2. Three-year, aged, Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.
- Q. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values when tested according to ASTM C1363 or ASTM C518:
1. Roof:
 - a. U-Factor: .031.
 - b. R-Value: R33.
 2. Walls:
 - a. U-Factor: U0.031.
 - b. R-Value: R32.

2.4 STRUCTURAL-STEEL FRAMING

- A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."
- B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.
- D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.
 1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
 - a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.
 2. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
 3. Frame Configuration: Single gable.
 4. Exterior Column: Tapered.
 5. Rafter: Tapered.
- E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:
 1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.

2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.
- F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, repainted with coil coating, to comply with the following:
1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
 - a. Depth: As needed to comply with system performance requirements.
 2. Purlins: Steel joists of depths indicated on Drawings.
 3. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.
 - a. Depth: As required to comply with system performance requirements.
 4. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
 5. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
 6. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
 7. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
 8. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
 9. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
 10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.
- G. Bracing: Provide adjustable wind bracing as follows:
1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
 2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
 3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
 4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
 5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.
- H. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.
- I. Materials:
1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
 2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
 3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
 4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
 5. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.
 6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).
 7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
 8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
 - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.
 9. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
 10. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
 11. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 (ASTM A563M) carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.
 - a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
 12. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH,

(ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

- a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
13. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490 (Grade A490M), Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
 14. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.
 - a. Finish: Mechanically deposited zinc coating, ASTM B695, Class 50.
 15. Unheaded Anchor Rods: ASTM F1554, Grade 36.
 - a. Configuration: Straight.
 - b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
 - c. Plate Washers: ASTM A36/A36M carbon steel.
 - d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
 - e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
 16. Headed Anchor Rods: ASTM F1554, Grade 36.
 - a. Configuration: Straight.
 - b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
 - c. Plate Washers: ASTM A36/A36M carbon steel.
 - d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
 - e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
 17. Threaded Rods: ASTM A193/A193M.
 - a. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
 - b. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
 - c. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
- J. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.
1. Clean and prepare in accordance with SSPC-SP2.
 2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).
 - a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 FOAMED-INSULATION-CORE METAL ROOF PANELS (BASE BID).

- A. Equivalent to Nucor's Classic Standing Seam SR2 Insulated Roof Panel.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Roof Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
 - 1. Panel Thermal-Resistance Value (R-Value): R33.
 - 2. Facing Material: Fabricate panel with exterior and interior facings of same material and thickness. Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch (0.76-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Exterior Finish: Two-coat fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 - 3. Panel Coverage: 40 inches (1067 mm) nominal.
 - 4. Panel Thickness: 4 inches (102 mm).
 - 5. Insulation Core: Modified polyisocyanurate or polyurethane foam using a non-CFC blowing agent, foamed-in-place or board type, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 - a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
 - b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D1622.
 - c. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D1621.
 - d. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C273/C273M.
 - 6. Fire-Test-Response Characteristics: Class A according to ASTM E108.
 - 7. Surface-Burning Characteristics: Flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.
- C. Finishes:
 - 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.6 METAL ROOF PANELS (DEDUCT ALTERNATE)

- A. Equivalent to Nucor's Classic Roof Panel.

- B. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and perpendicular intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.
1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Exterior Finish: Two-coat fluoropolymer.
 - b. Color: To match Butler, Cool Solar White.
 2. Clips: Two-piece floating to accommodate thermal movement.
 3. Joint Type: Mechanically seamed.
 4. Panel Coverage: 16 inches (406 mm).
 5. Panel Height: 2 inches (51 mm).
- C. Finishes:
1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.7 FOAMED-INSULATION-CORE METAL WALL PANELS

- A. Equivalent to Nucor's Double Mesa Profile (DM40) Insulated Wall Panel.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
1. Panel Thermal-Resistance Value (R-Value): R16.
 2. Facing Material: Fabricate panel with exterior and interior facings of same material and thickness. Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch (0.76-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Exterior Surface: Smooth, flat.
 - b. Exterior Finish: Two-coat fluoropolymer.
 - c. Color:
 - 1) Color 1: As selected by Architect from manufacturer's full range.
 - 2) Color 2: Custom DTCC blue.
 - 3) Color 3: As selected by Architect from manufacturer's full range.

3. Panel Coverage: 40 inches (1016 mm) nominal.
4. Panel Thickness: 2.5 inches (102 mm).
5. Insulation Core: Modified polyisocyanurate or polyurethane foam using a non-CFC blowing agent, foamed-in-place or board type, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 - a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
 - b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D1622.
 - c. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D1621.
 - d. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C273/C273M.
6. Fire-Test-Response Characteristics: Class A according to ASTM E108.
7. Surface-Burning Characteristics: Flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

C. Finishes:

1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.8 METAL SOFFIT PANELS

- A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
- B. Metal Soffit Panels: Match profile and material of metal wall panels.
 1. Finish: Match finish and color of metal roof panels.
- C. Concealed-Fastener, Flush-Profile, Metal Soffit Panels : Formed with vertical panel edges and flush surface; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps.
 1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch (0.76-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

- a. Exterior Finish: Fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range to match metal roof panels.
2. Panel Coverage: 16 inches (406 mm).
 3. Panel Height: 1 inch (25 mm).

2.9 THERMAL INSULATION.

- A. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.
- B. Unfaced Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.
- C. Retainer Strips: For securing insulation between supports, 0.025-inch (0.64-mm) nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.
- D. Mineral-Fiber-Blanket Insulation: (Including as part of Deduct Roof Alternate) ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.
 1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
- E. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M, Desiccant Method.
 1. Composition: White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.
 2. Composition: White polypropylene film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
 3. Composition: White polypropylene film facing and fiberglass-polyester-blend fabric backing.
- F. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 PERSONNEL DOORS AND FRAMES

- A. Swinging Personnel Doors and Frames: As specified in Section 081113 "Hollow Metal Doors and Frames."
- B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS, Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS, Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

C. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.
 - a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Factory-Applied Paint Finish: Manufacturer's standard, complying with SDI A250.3 for performance and acceptance criteria.
 - a. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.11 WINDOWS

- A. Aluminum Windows: As specified in Section 085113 "Aluminum Windows."

2.12 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
- B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
 2. Clips: Manufacturer's standard, formed from stainless-steel sheet, designed to withstand negative-load requirements.

3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from stainless-steel sheet or nylon-coated aluminum sheet.
 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch (25-mm) standoff; fabricated from extruded polystyrene.
- C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.
1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
 2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, **[0.018-inch (0.46-mm)] [0.030-inch (0.76-mm)]** nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
- E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."
1. Gutter Supports: Fabricated from same material and finish as gutters.
 2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.
- F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.
- G. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch (0.91-mm) nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.
1. Blades: Fixed.
 2. Free Area: Not less than **7.0 sq. ft. (0.65 sq. m)** for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 3. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; with rewirable frames, removable and secured with clips; fabricated of same kind and form of metal and with same finish as louvers.
 - a. Mounting: Interior face of louvers.
 4. Vertical Mullions: Provide mullions at spacings recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
- H. Roof Curbs: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness prepainted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.
1. Curb Subframing: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness, angle-, C-, or Z-shaped metallic-coated steel sheet.
 2. Insulation: 1-inch- (25-mm-) thick, rigid type.
- I. Skylights: As specified in Section 086213 "Unit Skylights."
- J. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
- K. Materials:
1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 - a. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
 - b. Fasteners for Metal Roof Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

- c. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with EPDM sealing washers bearing on weather side of metal panels.
 - d. Fasteners for Metal Wall Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM sealing washers bearing on weather side of metal panels.
 - e. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
 - f. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
 3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
 4. Metal Panel Sealants:
 - a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
 - b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.13 FABRICATION

- A. General: Design components and field connections required for erection to permit easy assembly.
 1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
 2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
 1. Make shop connections by welding or by using high-strength bolts.
 2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
 3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
 4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.

5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.
- D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
1. Make shop connections by welding or by using non-high-strength bolts.
 2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.
- E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
 1. Engage land surveyor to perform surveying.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written instructions and drawings.

- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
 - 1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.
 - a. Joint Type: Snug tightened or pretensioned as required by manufacturer.
- G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
 - 1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 - 2. Locate and space wall girts to suit openings such as doors and windows.
 - 3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
 - 1. Tighten rod and cable bracing to avoid sag.
 - 2. Locate interior end-bay bracing only where indicated.

- I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
 - 1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
- C. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 - a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
 - 2. Install metal panels perpendicular to structural supports unless otherwise indicated.
 - 3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Locate metal panel splices over structural supports with end laps in alignment.
 - 6. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- D. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.
 - 1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
- E. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

- F. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.
 - 1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

- A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
 - 1. Install ridge caps as metal roof panel work proceeds.
 - 2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.
 - 1. Install clips to supports with self-drilling or self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
 - 5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
 - 6. Provide metal closures at peaks, rake edges, rake walls and] each side of ridge caps.
- C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

- A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
 4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
 5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
 6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 7. Install screw fasteners in predrilled holes.
 8. Install flashing and trim as metal wall panel work proceeds.
 9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
 10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
 11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- B. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches (1067 mm) o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.
1. Install clips to supports with self-tapping fasteners.
 2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.
- C. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), noncumulative; level, plumb, and on location lines; and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 METAL SOFFIT PANEL INSTALLATION

- A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.
- B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.8 THERMAL INSULATION INSTALLATION

- A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.
 1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.

2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

3.9 DOOR AND FRAME INSTALLATION

- A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.
- B. Personnel Doors and Frames: Install doors and frames according to NAAMM-HMMA 840. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:
 1. Between Doors and Frames at Jambs and Head: 1/8 inch (3 mm).
 2. Between Edges of Pairs of Doors: 1/8 inch (3 mm).
 3. At Door Sills with Threshold: 3/8 inch (9.5 mm).
 4. At Door Sills without Threshold: 3/4 inch (19.1 mm).
 5. At fire-rated openings, install frames according to, and doors with clearances specified in, NFPA 80.
- C. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."
- D. Door Hardware:
 1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
 4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.10 WINDOW INSTALLATION

- A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.
 1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

- B. Set sill members in bed of sealant or with gaskets, for weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Mount screens directly to frames with tapped screw clips.

3.11 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
 - 1. Provide elbows at base of downspouts to direct water away from building.
 - 2. Tie downspouts to underground drainage system indicated.

- E. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.
 - 1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
 - 2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
 - 3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
 - 4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.
- F. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
- G. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.12 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.
- B. Product will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.13 ADJUSTING

- A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.
- B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.
- C. Windows: Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and at weather stripping to ensure smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.14 CLEANING AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

- C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.
 - 1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- D. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
 - 1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- F. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer.
 - 1. Immediately before final inspection, remove protective wrappings from doors and frames.
- G. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.
- H. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
 - 1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 133419

PROJECT MANUAL

Bid Documents
Delaware Technical and Community
College Automotive Center of Excellence
EDA PROJECT #01-01-14801
Georgetown, Delaware

Volume III
DIVISION 00 THROUGH DIVISION 05



ARCHITECTURE
ENGINEERING

Becker Morgan Group, Inc.
312 West Main Street, Suite 300
Salisbury, Maryland 21801

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PART 1. GENERAL

1.1. SUMMARY

- A. All work under Division 21 is subject to the Division 01, General Conditions and Special Requirements for the entire contract.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Submittals specified below. The right is reserved to make reasonable changes in location of equipment, and piping up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 21 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.
- H. Account for a future addition in the hydraulic calculations and provide proper pipe sizes for the same.

1.2. PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with the Division 01, General Requirements of the specification.

1.3. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractors failure to do so.

- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.4. CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 21 shall be fully qualified and acceptable to the Architect and Owner. Submit the following evidence when requested:
 - 1. A list of not less than five comparable projects which the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership in trade or professional organizations where required.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.5. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.6. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.7. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.
- B. ASTM - American Society for Testing and Materials
- C. FM - Factory Mutual
- D. IBC - International Building Code
- E. IEEE - Institute of Electrical and Electronics Engineers
- F. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry
- G. NEC - National Electrical Code
- H. NEMA - National Electrical Manufacturers Association
- I. NFPA - National Fire Protection Association
- J. UL - Underwriters' Laboratories
- K. State of Delaware Fire Protection Requirements.
- L. All equipment materials, piping and installation shall comply with the codes and standards listed in the enforceable edition of the Applicable National Fire Protection Association Pamphlets.
- M. Fire Protection Systems design, equipment and installation shall comply with the Delaware State Fire Prevention Regulations, latest edition including all Annexes and Addendums.

1.8. SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.
- B. After acceptance of Material and Equipment List, submit six (6) copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.
- C. Thoroughly review and stamp all submittals to indicate compliance with contract

requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

- D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.
- E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.
- F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- I. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.9. SHOP DRAWINGS

- A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.
- D. Items and Systems
 - 1. Access Doors/Panels including layout and location

2. Alarm Check Valves
 3. Backflow Preventers
 4. Coordinated Drawings
 5. Drip Pans
 6. Fire Department Connection
 7. Fire Protection System including Hydraulic Calculations, Equipment and Devices
 8. Fire Stopping - Methods and Materials
 9. Gongs
 10. Identification System
 11. Material and Equipment List
 12. Operations and Maintenance Manuals
 13. Pipe Materials Including Itemized Schedule
 14. Preliminary Pipe Pressure Tests
 15. Pressure Gauges
 16. Strainers
 17. Test Certificates
 18. Valves
 19. Wiring Diagrams, Flow Diagrams and Operating Instructions
 20. Zone Valve Assemblies
- E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked Reviewed or Comments Noted. After the proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect.
- F. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- 1.10. SUPERVISION AND COORDINATION
- A. Provide complete supervision, direction, scheduling, and coordination of all work under

the Contract, including that of subcontractors.

- B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, equipment, and other work performed under Division 21.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for fire protection installations.
- D. Coordinate electrical work required under Division 21 with that under Division 26. Coordinate all work under Division 21 with work under all other Divisions.
- E. Supply services of an experienced (10 years minimum) and competent Project Manager to be in constant charge of work at site.
- F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.
- G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.
- H. Coordinate installation of large equipment requiring positioning before closing in building.

1.11. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.
- B. Where pipes penetrate roofs, flash pipe with Stoneman Stormtite, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.
- C. Furnish and install pitch pockets or weather tight curb assemblies where required.
- D. Furnish and install curbs, specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.12. EXCAVATION AND BACKFILLING

- A. General
 - 1. Perform all necessary excavation, or installation of work under Division 21, in whatever materials or conditions encountered, using suitable methods and

- equipment.
2. Accurately establish required lines and grades and properly locate the work.
 3. Determine the locations of all existing utilities before commencing the work.
- B. Excavation: (Refer also to other portions of the specifications)
1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
 2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
 3. Keep excavations dry. Protect excavations from freezing.
- C. Backfilling: (Refer also to other portions of the specifications)
1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
 2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
 3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
 4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.13. DRIVE GUARDS

- A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.
- B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.14. VIBRATION ISOLATION

- A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, or piping to building structure. See Division 23 Section, "Vibration Control for HVAC Plumbing and Fire Protection Equipment".

1.15. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section

affected by alternates.

1.16. DEFINITIONS

- A. Approve - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. Furnish and install or provide means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- C. Contractor means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- D. Piping includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. Concealed means hidden from sight in chases, formed spaces, shafts, hung ceilings, or embedded in construction.
- F. Exposed means not installed underground or concealed as defined above.
- G. Invert Elevation means the elevation of the inside bottom of pipe.
- H. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. Review - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- J. Building Line: Exterior wall of building.

1.17. FUTURE ADDITIONS

- A. Where future additions are indicated, size, calculate, and install all piping to account for future additions. Furnish and install control valve with tamper switch in ceiling adjacent to future additions. Provide cap at the end of the piping. Arrange so that in the future the cap can be removed and control valve opened to serve future additions without draining system.

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

- A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 21 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 21. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 21.

- B. All electrical work performed under Division 21 shall conform to the applicable requirements of Division 26 and conforming to the National Electrical Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the IBC.
- C. Provide wiring diagrams with electrical characteristics and connection requirements.
- D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.
- E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.
- F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.
- G. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- H. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.
- I. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. WIRING DIAGRAMS

- A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.
- B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install fire protection 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.

- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- G. Do not install equipment or piping over electrical gear, electrical panels, motor controllers, and similar electrical equipment. Install equipment and piping to maintain clear space above and in front of all electrical components per the National Electric Code.

3.2. SUPPORTS, HANGERS, AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of galvanized steel utilizing galvanized rods, nuts, washers, bolts, etc. At contractor's option stainless steel may be utilized for exterior hangers, rods, nuts, washers, bolts, etc.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record demonstration and training video recordings. Record each training module separately.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
- D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4. PROVISIONS FOR ACCESS

- A. The contractor shall provide access panels and doors for all concealed equipment, valves, strainers, controls, control devices, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.
 - 1. Acoustical or Cement Plaster: Style B
 - 2. Hard Finish Plaster: Style K or L
 - 3. Masonry or Dry Wall: Style M
- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.
- F. Where access doors are installed in wet locations (i.e. shower rooms, toilet rooms, and similar spaces, etc.) provide aluminum access doors/frames.

3.5. PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 21 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed.
- F. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.

H. All exposed piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.6. CLEANING OF SYSTEMS

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting equipment, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.

B. Flush piping to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating the name of Service Company used.

C. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

D. Leave systems clean, and in complete running order.

3.7. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.8. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.9. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during

construction.

- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
 - C. Submit factory start-up sheets or field start-ups sheets for all equipment.
- 3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS
- A. Contractor shall submit for approval working fire protection drawings of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
 - B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as "Normally Open" or "Normally Closed" as required.
 - C. All items of equipment, including motor starters and disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal). Equipment identification and room name or area served shall be on each label.
 - D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the Operation and Maintenance Booklet as hereinafter specified.
 - E. All piping installed under this contract shall be stenciled with direction of flow arrows and with stenciled letters naming each pipe and service. Refer to Division 21 Section, "Fire Protection Piping, Fittings, Valves, Etc". Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.
 - F. Submit list of wording, symbols, letter size, and color coding for fire protection identification. Submit samples of equipment identification cards, piping labels, and valve tags to Engineer for review prior to installation.
 - G. Provide at least hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner.
 - H. Contractor shall demonstrate Sequences of Operation of all fire protection equipment in presence of Owner's representative, and Fire Marshal.
- 3.11. WALL AND FLOOR PENETRATION
- A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 21 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.

- B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, "Fire Protection, HVAC and Plumbing Protection Firestopping".
- C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.
- D. Provide pipe escutcheons for sleeved pipes in finished areas.
- E. Piping sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.
- F. Extend all floor sleeves through floor at least 2-inches above finished floor, caulk sleeve the entire depth and furnish and install floor plate.

3.12. RECORD DRAWINGS

- A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect one complete set of prints of the fire protection drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the GENERAL CONDITIONS.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The contractor guarantees for a two year period from the time of final acceptance by the Owner.
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
 - 3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The

contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

3.14. OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared six (6) hardcopies and one (1) electronic copy of the Operation and Maintenance Manuals and deliver these copies of the manuals to the Owner. The manuals shall be as specified herein. The manuals must be approved and will not be accepted as final until so stamped.
- B. The manuals shall be bound in a three ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: Operations and Maintenance Manuals – Owens Campus Automotive Training Facility– Fire Protection. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.
- C. Provide the following data in the booklet:
 1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 3. Manufacturer's extended limited warranties on equipment.
 4. Chart form indicating frequency and type of routine maintenance for all fire protection equipment. The chart shall also indicate model number of equipment, location and service.
 5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
 6. Provide supplier and subcontractor's names, address, and phone number.
 7. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
 8. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass.
 9. Access panel charts with index illustrating the location and purpose of access panels.
 10. Approved Fire Protection Certificates.
 11. Start-up reports for equipment.

- D. Submit Operations and Maintenance Manuals prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Operations and Maintenance Manuals be reviewed and approved.

3.15. INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:
 - 1. Complete Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.
- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, and piping in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer’s literature showing internal wiring.

3.16. PIPING SYSTEMS TESTING

- A. The entire new fire protection piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Fire Protection (Refer to NFPA)	200 psi

- B. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the Operations and Maintenance Manuals.

3.17. OUTAGES

- A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.
- B. Submit Outage Request form, attached at end of this Section, to Owner for approval.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE -- TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____

(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ___ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER: _____

OWNER'S PRESENCE REQUIRED: _____

YES: ___ NO: ___ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

SECTION 210505 - FIRE PROTECTION PIPING, FITTINGS AND VALVES

PART 1. GENERAL

1.1. SUMMARY

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

1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings.
- B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and the authority having jurisdiction.
- C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- F. Provide pipe hangers and supports in accordance with ASTM B31.9, MSS SP69 and NFPA-13 unless indicated otherwise.
- G. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- C. If the product is available domestically it shall be supplied as such.

1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.6. EXTRA MATERIALS

- A. Provide one (1) repacking kit for each size valve.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.
 - 1. Fire Protection Piping (NFPA-13):
 - a. Piping Underground: Steel, schedule 40, ASTM A53, black pipe with ASME C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape, or listed ductile iron pipe.
 - b. Piping Above Grade (Inside): Steel, schedule 40, ASTM A53, black pipe. Piping 4 inches and smaller shall be ASTM A120, black steel pipe. Sizes 4-inches and above shall be standard weight, black, cast iron with screwed fittings, schedule 10 steel piping shall be acceptable when approved by the authority having jurisdiction.
 - c. Piping Above Grade (Outside): Galvanized Steel
 - d. Wet Pipe Fittings: Steel fittings shall be ASME B16.9, wrought steel, butt welded. Cast iron fittings shall be ASME 16.1, flanges and flanged fittings. Malleable iron fittings shall be ASME B16.3, threaded fittings. Mechanical grooved couplings shall be malleable iron housing clamps to engage and lock C shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe. Mechanical formed fittings shall be carbon steel housing with integral pipe stop and O-ring and O-ring uniformity compressed into permanent mechanical engagement onto pipe.
 - e. Victaulic, Grinnell, or approved equal, grooved end fittings and mechanical couplings shall be used for wet pipe and dry pipe systems 2" and larger. Couplings and fitting shall be UL listed and FM approved. Fittings shall be ASTM A536 ductile iron, ASTM A234 forged steel or ASTM A53 fabricated steel with factory grooved ends designed to accept

Victaulic couplings.

- f. Victaulic, Grinnell, or approved equal, mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive, synthetic rubber gasket and plated steel bolts and nuts.
 - i. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA-13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer’s latest recommendation.
 - 1) 1-1/4” through 8”: “Installation Ready” stab-on rigid coupling, designed for direct ‘stab’ installation onto grooved end pipe without prior field disassembly and no loose part. Victaulic FireLock EZ Style 009H (1-1/4” – 4”) and Victaulic QuickVic Style 107H (2”-8”).
 - 1) 2” and Larger: Standard rigid coupling design. Victaulic Style 07 Zero-Flex.
 - ii. Flexible Type: use in seismic areas and where required by NFPA-13.

Fire Protection Service	Temperature Range	Gasket Recommendation
Water/Wet Systems	Ambient	Grade EPDM, Type A-C Shaped, FireLock EZ, or QuickVic Design

- g. Gate Valves: 2-1/2 inches & larger - listed 175 lb. OS&Y, flanged. 2 inches & smaller - UL/FM listed 175 lb., bronze, screwed. Furnish all sprinkler control valves with slow close manual operator and position indicator. Tamper switches furnish under Division 21.
- h. Grooved End Gate Valves: 2-1/2inches and Larger – UL listed/FM approved, 250 psi maximum pressure rating, OS&Y, ductile iron body, bronze mounted, grooved ends. Victaulic FireLock Series 771.
- i. Grooved End Butterfly Valves: 2 inches & Larger: UL listed/FM approved, up to 365 psi maximum pressure rating, ductile iron body, nickel-plated ductile iron disc, Nitrile seat, weather-proof actuator with two pre-wired supervisory switches. Victaulic FireLock Series 765 or Series 705.
- j. Globe Valves: 2 inches & smaller - 175 lb., bronze, screwed, UL/FM listed.
- k. Check Valves: 2-1/2 inches & smaller - UL/FM listed 175 lb., flanged swing check. 2 inches & smaller - listed 175 lb., bronze swing check, screwed.
- l. Grooved End Check Valves: 2 inches and Larger: UL listed/FM approved, up to 365 psi maximum pressure rating, ductile iron body, spring-loaded stainless steel or EPDM coated ductile iron disc, nickel-plated or welded-in nickel seat. Victaulic FireLock Series 717H or Series 717.
- m. Finish: All exposed fire protection piping shall be primed and painted with epoxy red paint. White letters shall indicate pipe and indicate direction of flow. Painting shall be provided under Division 09.

- n. Special Requirements: All fire protection piping, valves, fittings and joints shall comply with applicable National Fire Protection Pamphlets (NFPA) local codes, building codes, Fire Marshal, Owner's Insurance Underwriter, and the authority having jurisdiction.
- B. Steel pipe shall be similar and equal to National Allied Tube or Wheatland black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.
- C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.
- D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS

- A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe 3/4-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - 1/2	6	8	3/8
2	8	8	3/8
2 - 1/2	10	9	1/2
3	12	10	1/2
4	14	12	5/8
5	14	12	5/8

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8
12	20	18	7/8

- B. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.
- C. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring, comply with NFPA-13.
- D. Hangers for pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis. Comply with NFPA-13.
- E. Hangers for cold pipe sizes 6 inches (150 mm) and over: adjustable steel yoke, cast iron roll, double hanger, comply with NFPA-13.
- F. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.
- G. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook, comply with NFPA-13.
- H. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp, comply with NFPA-13.
- I. Wall support for pipe sizes 6 inches (150 mm) and over: welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll, comply with NFPA-13.
- J. Vertical Support: Steel riser clamp, comply with NFPA-13.
- K. Floor support for pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support, comply with NFPA-13.
- L. Copper pipe support: Carbon steel ring, adjustable, copper plated, comply with NFPA-13.

- M. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded, comply with NFPA-13.
- N. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- O. Victaulic Style 009H, 107H, and 07, Grinnell, or approved equal, rigid couplings may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA-13. An adequate number of Victaulic Style 177, 75, and 77, Grinnell, or approved equal, flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.3. VALVES

- A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer. All valves shall be provided with tamper switches and coordinated with Division 28.

2.4. PRESSURE GAUGES

- A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Terice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.
- B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.
- C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.
- D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.
- E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Terice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.5. ESCUTCHEONS

- A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.
- B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.6. DIELECTRIC CONNECTIONS:

- A. Furnish and install electrically insulated dielectric waterway fittings, unions or flanges, as manufactured by EPCO Sales, Inc., or Victaulic Co. at the following locations:
 - 1. Where steel piping systems join copper piping.
 - 2. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.7. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.
- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend 3/4-inch above the floor. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.
- C. Sleeves through walls and floors shall be sealed with with a waterproof caulking compound.
- D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.8. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees F.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free

expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, and installed so that there will be no interference with the installation of the equipment. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.

- B. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.
- C. All valves and other fittings shall be readily accessible.
- D. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.
- E. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.
- F. Install all valves with stem upright or horizontal, not inverted.
- G. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.
- H. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- I. All water containing pipes shall be routed clear of louvers to prevent freezing condition when dampers are open.

3.2. PRESSURE GAGE INSTALLATION REQUIREMENTS.

- A. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.
- B. Adjust faces of gages to proper angle for best visibility.
- C. Clean windows of gages and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. 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.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. 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.
- F. Do not attempt to repair defective valves; replace with new valves.
- G. Install valves as indicated, according to manufacturer's written instructions.
- H. Piping installation requirements are specified in other Division 21 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- J. Locate valves for easy access and provide separate support where necessary.
- K. Install valves in horizontal piping with stem at or above the center of the pipe.
- L. Install valves in a position to allow full stem movement.
- M. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

3.4. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. **Screwed Joints:** All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.
- B. **Grooved Joints:** Install in accordance with the manufacturer's (Victaulic, Grinnell, or approved equal) guidelines and recommendations. All grooved 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. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation

of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

- C. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.
 - 1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
 - 2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
 - 3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
 - 4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
 - 5. Solder joints shall be made by using a direct flame from a torch.
 - 6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
 - 7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
 - 8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
- D. Where copper piping joins steel piping, approved bronze adapters shall be used.
- E. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

3.5. HANGERS AND SUPPORTS INSTALLATION REQUIREMENTS

- A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal. Comply with NFPA-13.

- B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping.
- C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.
- D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.
- E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.
- F. Select hangers and components for loads imposed. Secure rods with double nuts.
- G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.
- H. Support overhead piping with clevis hangers.
- I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.
- J. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- K. Construct concrete anchors of poured in place concrete of dimensions indicated and include embedded fasteners.
- L. Refer to structural documents for appropriate connection/attachment materials to building.

3.6. PIPING IDENTIFICATION INSTALLATION REQUIREMENTS

- A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.
- B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.7. VALVE IDENTIFICATION REQUIREMENTS

- A. All valves shall be tagged with a numbered tag.
- B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.
- C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.
- D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in the main fire protection riser room. Additional copies shall be provided in each copy of the O&M manuals.

END OF SECTION

SECTION 211003 - WATER BASED FIRE SUPPRESSION SYSTEM - SPRINKLERS

PART 1. GENERAL

1.1. REFERENCE

- A. The conditions of the Contract and General Requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 21 Section, Common Work Results for Fire Protection and Division 01 Section, General Requirements.
- B. Submit complete shop drawings of all equipment utilized with the system in accordance with Division 21 Section, Common Work Results for Fire Protection. Submittals shall include but not be limited to the following fire protection system and accessories:
 - 1. Ball Drip Valves
 - 2. Fire Department Connection
 - 3. Pressure Sensing Devices, Valves
 - 4. Alarm Check Valves
 - 5. Pressure/Vacuum Gauges
 - 6. Inspector's Test Station
 - 7. Eccentric Reducers
 - 8. Pressure Switches
 - 9. Valves and Piping
 - 10. Backflow Preventers
 - 11. Flow Switches
 - 12. Tamper Switches
 - 13. Main Drains
 - 14. Auxiliary Drains
 - 15. Blind Flange with Escutcheon
- C. Provide sprinklers, piping and associated equipment complete and ready for operation. Equipment materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with NFPA-13, NFPA-70, NFPA-72E, and NFPA-101. Devices and equipment for fire protection service shall be U.L listed or FM approved.
- D. All of the equipment and devices shall be included within the project Operations and

Maintenance Manuals.

- E. Refer to Division 21 Section, Fire Protection Pipes, Valves, and Fittings for pipe materials.
- F. Fire Protection Systems design, equipment and installation shall comply with the Delaware State Fire Prevention Regulations, latest edition including all Annexes and Addendums.

1.2. DESCRIPTION

- A. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this Section and as shown on the drawings. The work shall be performed by a licensed sprinkler contractor only. All equipment, piping, devices, and valves shall be sized based on hydraulic calculations. Include a 10 psig safety factor with hydraulic calculations.
- B. Layout sprinkler system complete and size all fire protection piping in accordance with requirements of the National Fire Protection Association and the State Fire Marshal. System shall be designed for occupancy as required by applicable codes. Conceal fire protection piping in finished spaces unless indicated otherwise. System drains and inspector's test shall not be located in finished spaces.
- C. Sprinkler equipment and work shall conform to requirements of National Fire Protection Association Standard No. 13, and No. 24. In addition, all work shall conform to requirements of all codes and regulations of authorities having jurisdiction over this work, including, but not limited to, State Fire Marshal, City of Georgetown Fire Marshal, Life Safety Codes and International Code, and Insurance Underwriter.
- D. Preliminary Shop Drawing: Prior to preparing detailed working drawings for submission to State Fire Marshal, submit preliminary sprinkler system layout to the Architect for review and approval. Show all finished ceilings, light fixtures, air diffusers and other ceiling mounted devices. Coordinate sprinkler head types and locations with ceiling types. All sprinkler heads in acoustic tile ceilings shall be centered in the tile.
- E. The fire protection contractor shall prepare dimensioned and detailed working drawings, specifications, and hydraulic calculations and submit same to the State Fire Marshal and/or County Fire Marshal for review and approval. Prior to submission to the Fire Marshal, the Fire Protection Contractor shall have all fire protection drawings, submittals, calculations reviewed and approved by a registered Fire Protection Engineer or a level III Nicet Technician. One set of these approved documents shall be provided to the Engineer for record purposes. All costs related to changes required to obtain the Fire Marshal's or Insurance Underwriters' approval shall be the responsibility of the contractor.
- F. Manufactured equipment and materials shall be submitted to the Engineer for review and approval, in accordance with the requirements of Division 21 Section, Common Work Results for Fire Protection.
- G. Hydraulic calculations should be based on an available water supply as follows:

Static Pressure =	52 psig
Residual Pressure =	46 psig
Flow =	1061 gpm

Existing Pipe Material	For Hydraulic Calculations Assume Roughness Coefficient C factor = 100 for all Exterior Piping.
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- H. Hydraulic calculations shall include a 10 psig safety factor to account for pipe aging and deterioration of water supply.
- I. For small areas subject to freezing (loading dock, exterior canopy, etc.), Contractor shall provide and install freeze proof heads, piping, control valves, tamper switches, test stations, as required by NFPA-13 and the authority having jurisdiction.
- J. Where combustible construction materials are located above ceilings, provide above ceiling fire protection in accordance with N.F.P.A-13.

1.3. DELIVERY, STORAGE AND PROTECTION

- A. Refer to Division 01 Section, General Requirements: Transport, handle, store, and protect products.
- B. Accept equipment and devices on site in factory packing. Inspect for damage. Comply with manufacturer's rigging and installation instructions for all equipment.
- C. Protect components from physical damage including effects of weather, water, and construction debris.
- D. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.4. EXTRA MATERIALS

- A. Provide extra sprinklers under provisions of NFPA-13. Provide suitable wrenches for each sprinkler type and metal storage cabinet.

1.5. PERMITS FROM THE AUTHORITY HAVING JURISDICTION AND FEES

- A. Pay all permits, fees, and charges required for this work.

1.6. HYDRANT FLOW TESTS

- A. The Fire Protection Contractor shall perform a hydrant flow test.
- B. The hydrant flow test shall be performed by the Fire Protection Contractor in the vicinity of each building at no additional cost to the Owner.
- C. Where practical, tests shall be performed between 9:00 a.m. and 5:00 p.m. on a normal working day during summer. If conducting the test is impractical during these hours, then a local Fire Department representative shall be present to "observe" the test during "off peak" hours and to acknowledge the correctness of results.
- D. The tests shall be submitted for review prior to submitting any hydraulic calculations. The test data shall contain the following:
 - 1. Date of the test
 - 2. Who performed the test and who was present.

3. Site plan indicating locations and diameters of water mains and locations of the hydrants tests.
4. Grade elevation of the hydrant tests
5. Static pressure in psig
6. Flow in GPM
7. Residual pressure in psig
8. Hydrant butt size in inches
9. Hydrant coefficient

1.7. ALTERNATES

- A. Refer to Division 01 Section, Alternates - Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. SPECIALTIES

- A. All sprinkler heads shall be U.L. listed and shall be of the same manufacturer throughout the building.
- B. Piping shall be in accordance with Division 21 Section, Fire Protection Piping, Fittings, and Valves, etc. All exposed fire protection piping in unfinished areas shall be painted with red epoxy paint. White letters shall identify piping and indicate direction of flow. Exposed fire protection piping within finished areas shall be painted in color as determined by the Architect/Engineer.
- C. Shut-off valves shall be UL approved O.S. and Y. double disc gate valves or UL/FM approved grooved end butterfly valves.
- D. Check valves shall be swing check type or spring-loaded type UL approved for the application.
- E. Fire department connection shall be Potter-Roemer 5750 Series, or approved equal, with individual drop clapper valves, plugs, and chains on each connection. Exposed parts shall be polished chrome plated. Threads shall match local Fire Department specifications. Where required by local Fire Department, provide Storz type Fire department connection. Escutcheon shall be lettered "AUTO SPRINKLER" as required. Locate as shown on drawings and connect to main fire line through check valve with ball drip. Discharge ball drip drain line as indicated on contract drawings.
- F. Coordinate the fire protection systems with the fire alarm system specified under Division 26. Provide alarm initiating devices with proper contact arrangement. All electrical wiring shall be furnished and installed under Division 26.
- G. Flow control valve, alarm switches and valve supervision shall be furnished and installed

under this Division. All wiring shall be accomplished by the electrical contractor, under Division 26. Provide any additional flow control valves, alarm switches, tamper switches and flow switches required by NFPA-13 but not indicated on contract drawings. Coordinate with the alarm system and electrical subcontractor.

- H. Pipe and fittings shall meet the requirements of NFPA 13, and NFPA-24.
- I. Wet pipe alarm check valve shall be Victaulic FireLock Series 750, or approved equal. Valve shall be UL listed and FM approved for sprinkler systems with 175 psig maximum working pressure. Provide complete valve trim package including all necessary valves, gauges, fittings, nipples and alarm test. Valve internal components shall be replaceable without removing the valve from the installed position. Valve shall be installed in the vertical position only.
- J. Retard Chamber shall be Victaulic Series 752. Retard Chamber shall be UL listed and FM approved. Chamber shall prevent false alarms with ordinary city water pressure surges.
- K. Water motor alarm shall be Victaulic Series 760. Alarm shall be UL listed and FM approved. Alarm shall be hydraulically driven and tested 100 percent at low flow, 5 psig. Gong assembly and motor housing shall be finished with corrosion resistant, red enamel. Furnish unit with nylon bearings and inlet strainer. At contractor's option install electric gong. Provide power and control wiring under this Division of specifications.

2.2. SPRINKLER HEADS

- A. Suspended or Drywall Ceilings:
 - 1. Manufacturer: Victaulic, Viking, Grinnell, Reliable, or approved equal.
 - 2. All sprinkler heads installed in suspended ceilings and drywall ceilings including bulkheads shall be Victaulic Model V38 concealed quick response sprinkler or approved equal. Cover plate shall be finished with a polyester baked enamel finish. Color selection by Architect. Provide cover assembly with each head. Frangible glass bulb shall be temperature rated for specific area hazard.
 - 3. Sprinkler heads in all other areas with finished ceilings shall be Victaulic Model V27 or approved equal. These sprinklers shall be standard pendant type with matching screw on escutcheon plate. Sprinkler and escutcheon plate finish shall be chrome plated. Fusible link shall be temperature rated for specific area hazard.
- B. Exposed Area Type:
 - 1. Manufacturers: Victaulic, Viking, Grinnell, Reliable, or approved equal.
 - 2. Sprinkler heads in unfinished or exposed areas shall be Victaulic Model V27, or approved equal. These sprinklers shall be standard, ½ inch upright, pendant or conventional where required. Provide guards where hereinafter indicated. Sprinklers shall be brass with frangible glass bulb temperature rated for specific area hazard. Provide standard brass, screw on flat escutcheon plate.
- C. Sidewall type:

1. Manufacturers: Victaulic, Viking, Grinnell, Reliable, or approved equal.
 2. Sidewall sprinklers shall be Victaulic Model V27 semi-recessed horizontal sidewall type with matching screw on escutcheon plate. Sprinkler and escutcheon plate finish shall be chrome plated. Frangible glass bulb shall be temperature rated for specific area hazard.
- D. Quick Response Type:
1. Manufacturers: Victaulic, Viking, Grinnell, Reliable or approved equal.
 2. Sprinkler heads, shall be listed quick response sprinklers in accordance with NFPA-13 and NFPA-101. Quick response sprinklers shall be Victaulic Model V27 or approved equal. Model and deflector style shall be as required to accommodate upright, pendant, sidewall or recessed mounting. Sprinklers and escutcheon plates shall be chrome plated. Frangible glass bulb shall be temperature rated for specific area hazard.
- E. The temperature rating of the sprinklers shall be as required by N.F.P.A.-13 and or the authority having jurisdiction.
- F. All sprinkler heads installed in lay-in ceiling tiles shall be located in the center of the tile to provide a symmetrical, aesthetic and neat appearance. All sprinkler heads installed in bulkheads, recesses, and soffits shall be centered to provide a symmetrical, aesthetic and neat appearance.
- G. Provide extended escutcheons in rooms with surface mounted lighting fixtures.
- H. Additional heads shall be furnished as required by NFPA-13. The heads shall be in a cabinet designed to hold the heads and include one sprinkler head wrench for each type of sprinkler. Cabinet shall be mounted where indicated in the field.
- I. Head guards shall be provided in mechanical spaces, penthouses, janitors' closets, electrical rooms, and storage areas. Finish for head guards in finished spaces shall be selected by Architect.
- J. Sprinkler escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.
- K. Provide high temperature sprinkler heads for use adjacent to skylights, heaters, lights, or other high temperature areas.
- 2.3. FLEXIBLE SPRINKLER DROPS
- A. Stainless Steel Sprinkler Fittings
1. Manufacturer: Victaulic AquaFlex®
 2. In lieu of rigid pipe offsets for concealed locations only, or return bends for sprinkler drops, the Victaulic AquaFlex® stainless steel, multiple-use, sprinkler fitting system may be used to locate sprinklers as required by final finished ceiling

tiles and walls. The drop system shall consist of a braided or unbraided (corrugated) type 304 stainless steel flexible tube, a zinc-plated steel 1" NPT male threaded nipple for connection to branch-line piping, and a zinc-plated steel reducer with 1/2" or 3/4" NPT female thread for connection to the sprinkler head. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket. The braided drop system is FM approved for sprinkler services to 200 psi and can be installed without the use of tools, and the unbraided system is UL listed for sprinkler services to 175 psi.

2.4. SIGNS

- A. Provide 9 inch x 7 inch signs suspended from control valves which indicate the purpose of the valve and its normal position, Central Type A or approved equal.
- B. All control, drain, and test connection valves shall be provided with signs indicating purpose.
- C. Signs shall be fabricated of an approved material, painted red with white lettering.
- D. Signs shall have typed labels. Handwritten labels shall not be acceptable.

2.5. DRAINS

- A. The sprinkler systems shall be arranged to be completely drainable. Means of drainage shall be provided with adequate protection from freezing.
- B. Drain valve may be combined with sprinkler alarm test valve and sight glass, G/J Innovations Sure-Test or approved equal. Valve shall be UL listed with positive off handle for off, test or drain, integral sight glass, orifice size equal to smallest sprinkler orifice and full 1 inch drain.

2.6. ALARM DEVICES

- A. Approved water flow switches shall be installed to activate the fire alarm, and annunciate sprinkler flow at a minimum on each floor, each system riser, where indicated on the contract documents and where required by N.F.P.A. or the authority having jurisdiction. Conductors shall be provided under the electric division to provide fire alarm, and annunciation. Activation of the sprinkler system by one sprinkler or equivalent test shall cause the fire alarm system to activate, and the appropriate lamp(s) to activate on the annunciator. An approved test shall be provided for each water flow switch.
- B. All valves controlling water supply for sprinklers shall be electrically supervised in accordance with requirements of NFPA 13 and 72A, and provided under this Division. Provide separate valve chart for all fire protection valve indicating valve type, normal position, size, location and type of supervision insert in O&M manual and mount additional copies in fire pump room and mechanical rooms.
- C. Valve tamper switches shall be Model OSY2 as manufactured by System Sensor or Model OSYSU-A2 as manufactured by Potter Electric Signal Company or approved equal. The valve tamper switches shall monitor the open position of all OS&Y gate valves. Each

tamper switches shall contain two sets of single pole double throw, Form C contacts. All valve tamper switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Tamper switches shall be suitable for 125/250 VAC @ 15 AMPS. All tamper switches shall be U.L. listed and F.M. approved.

- D. Pressure type flow switches shall be Model EPS10 as manufactured by System Sensor or Model PS10-2 as manufactured by Potter Electric Signal Company or approved equal. Each pressure type flow switch shall contain two sets of single pole double throw switch contacts. All pressure type flow switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Pressure type flow switches shall be suitable for 125/250 VAC @ 10 AMPS. All pressure type flow switches shall be U.L. listed and F.M. approved.
- E. Vane Type waterflow switch with retard shall be WFD Series as manufactured by System Sensor or Model VSR-F as manufactured by Potter Electric Signal Company or approved equal. The VAC type waterflow switches shall contain two single pole, double throw form C, snap return switches. All Vane type waterflow switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Vane type waterflow switches shall be suitable for 125/250 VAC @ 10 AMPS. All vane type waterflow switches shall be U.L. listed and F.M. approved.

2.7. GAUGES

- A. A listed 3 ½ inch dial spring pressure gauge shall be connected to the top of each standpipe. Gauges shall be located in a suitable place to prevent freezing. Each gauge shall be controlled by a valve having arrangement for draining.
- B. Listed pressure gauges with connections not smaller than ¼ inch shall be installed at the system main drain, at each main drain associated with a floor control valve, and above and below each alarm check-valve.
- C. All pressure gauges shall be listed and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal and shall be located where they will not be subject to freezing.

2.8. DOUBLE DETECTOR CHECK VALVE BACKFLOW PREVENTER (FIRE PROTECTION SYSTEM)

- A. The sprinkler system backflow preventer shall be provided under this Division and coordinated with Plumbing Contractor. Backflow preventer shall be sized for sprinkler demand to limit pressure drop to 5 psig.
- B. Backflow preventers for Fire Protection Systems shall be ASSE/AWWA-1015 approved, double detector check-valve backflow preventer assemblies at sprinkler system water service connections. Units shall be specifically listed for Fire Protection use. Units shall be double detector check valve as manufactured by Watts 709 DCDA, Ames, Conbraco, Wilkens, or approved equal with OS&Y Gate valves, U.L. listed, F.M. approved, NSF-61 approved. Units shall be suitable for minimum 175 psi working pressure. Backflow preventers shall be factory tested at two (2) times the working pressure encountered or as required by N.F.P.A. Backflow preventer shall be capable of withstanding test pressures per N.F.P.A.

- C. Backflow preventer shall be factory finished with epoxy coated paint or shall be 304 stainless steel.
- D. Pipe any discharge openings full size, through air gap fittings, to nearest floor drain. Maintain clearances for servicing as required by Plumbing Code and authority having jurisdiction. Discharge piping shall be Type L copper pipe.
- E. Provide and install tamper switches on all backflow preventers OS&Y gate valves or butterfly valves. Backflow preventer shall be installed between 12 inches and 60 inches above finished floor. Provide 18 inch clearance around backflow preventer for service and maintenance.
- F. Unit shall include auxiliary piping with approval backflow preventer and water meter. Meter shall indicate flow in gallons per minute.

2.9. AUTOMATIC BALL DRIP VALVES

- A. Provide and install automatic ball drip valves at the Fire Department connection. Discharge ball drip valves to closest floor drain or building exterior as required, with suitable air gap. Automatic ball drip valves shall be ITT-AC Pump or approved equal.

2.10. VALVES

- A. Provide and install control valves as indicated on contract drawings and as required by N.F.P.A.-13. Gate valves shall be listed O.S. & Y. type. All control valves shall be supervised open. Supervision shall be as required by N.F.P.A.-13. Victaulic Series 705 and 765 grooved end butterfly valves shall be supervised in the open position.

2.11. BLIND FLANGE FOR FORWARD FLOW TESTING OF BACKFLOW PREVENTER

- A. A blind flange with normally closed control valve shall be provided for use in forward flow testing of backflow preventer. Blind flange shall be sized to flow entire system demand in accordance with NFPA-13 and NFPA-25, latest edition. Control valve shall be monitored with tamper switch.
- B. Identify and label blind flange "Backflow Preventer Test Connection" to differentiate fitting on exterior wall from Fire Department connection.
- C. Install ball drip in test pipe to allow drainage and prevent freezing.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

- A. Install equipment in accordance with manufacturer's instructions.
- B. Where required, install buried shut-off valves in valve box. Provide post indicator.
- C. Provide approved double check valve assembly at sprinkler system water source connection.
- D. Locate fire department connection with sufficient clearance from walls, obstructions, or

- adjacent Siamese connectors to allow full swing of fire department wrench handle.
- E. Locate outside alarm gong on building wall.
 - F. Place pipe runs to minimize obstruction to other work.
 - G. Place piping in concealed spaces above finished ceilings.
 - H. Center sprinklers in two directions in ceiling tile and provided piping offsets as required.
 - I. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
 - J. Flush entire piping system of foreign matter.
 - K. Install guards on sprinklers where subject to abuse and where specified.
 - L. Hydrostatically test entire system.
 - M. Test must be witnessed by Fire Marshal/authority having jurisdiction/ Owner's insurance underwriter/ Architect/Engineer.
 - N. Refer to plumbing floor plans for approximate locations of sprinkler zones control valve assemblies and routing of fire protection mains.
 - O. Locate inspectors test stations for sprinkler zones per NFPA-13. Provide and install drain piping from all approved terminations. Provide splash blocks for terminations outside. Splash block locations shall be approved by the Architects.
 - P. The fire protection contractor shall hydraulically prove the most remote area per NFPA-13.
 - Q. Coordinate locations of sprinkler heads with lights, diffusers, ceiling types, etc.
 - R. Hydrostatically test system at 200 PSI for 4 hours, per NFPA-13.
 - S. Provide dry pipe sprinklers at all loading docks, canopies, etc., as required by NFPA-13.
 - T. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.
 - U. Refer to Architectural Drawings for exact location and extent of all fire rated walls and smoke barriers.
 - V. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. All grooved 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. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations,

projections, and roll marks in the area from pipe end to groove for proper gasket sealing.

3.2. INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

3.3. LAYOUT

- A. Coordinate layout and installation of fire protection system with all other buildings structural, mechanical and electrical work. Locate sprinkler heads symmetrically with respect to ceiling tiles, lighting fixtures, registers, grilles, diffusers, etc. Provide piping offsets as required to maintain symmetry. Note that a preliminary sprinkler layout is to be submitted for review. Contractor is cautioned that sprinkler mains must be located to prevent conflict with other work and in any case, sprinkler contractor shall be responsible for coordination of his work with work of other trades.
- B. Unless otherwise indicated, the entire building shall be protected throughout with a wet pipe sprinkler system.

3.4. WET PIPE SPRINKLER SYSTEM

- A. System components shall include, but not be limited to flow control valves, electrical connections to central fire alarm system, fire department connection, check valves, main piping, branch piping, inspector's test, drains, sprinkler heads, hose valves and cabinet, ball drip valves, signs, standpipes, etc. and all other incidental appurtenances as required.

3.5. VALVE INSTALLATION

- A. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.
- B. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- C. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.

3.6. CONNECTIONS

- A. Connect water supplies to standpipes and sprinklers. Include backflow preventers.
- B. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- C. Connect piping to specialty valves, specialties, fire department connections, and accessories.
- D. Connect alarm devices to fire alarm.

3.7. COMMISSIONING

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Verify that potable-water supplies have correct types of backflow preventers.
- F. Verify that fire department connections have threads compatible with local fire department equipment
- G. Fill wet-pipe sprinkler piping with water.
- H. Energize circuits to electrical equipment and devices.
- I. Adjust operating controls and pressure settings.
- J. Coordinate with fire alarm tests. Operate as required.

3.8. DRAINS

- A. The sprinkler system shall be arranged to be completely drainable. Means of drainage shall be provided with adequate protection from freezing.

3.9. TESTS

- A. The sprinkler systems installation shall be hydrostatically tested, inspected, and approved, in accordance with NFPA Standard No. 13 and NFPA Standard No. 25. Test certificate shall be forwarded to the Office of the State and/or Georgetown, DE Fire Marshal and the Architect as proof of compliance.
- B. Tests shall be performed in accordance with the requirements of the Office of the State Fire Marshal and shall prove the systems to be adequate and satisfactory in every respect. All tests shall be performed in the presence of the State Fire Marshal or his representative.
- C. Any deficiencies revealed by these tests shall be corrected and the systems shall be retested until acceptable results are obtained.

3.10. AS-BUILT DRAWINGS & PROJECT CLOSEOUT

- A. Provide separate as-built drawings of all fire protection systems meeting requirements of General Mechanical Requirements hereinbefore specified.
- B. At the completion of the work, provide a sealed plan of the building indicating the locations of all control valves, low point drains, flow switches, and Inspectors Test Stations. The plan shall be neatly drawn and color coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall adjacent to the

system header.

- C. Include manufacturers literature, cleaning procedures, replacement parts, lists, and repair data for equipment.
- D. Include manufacturers' instructions, start-up data, troubleshooting, and check lists for all equipment.

3.11. WARRANTY

- A. The Contractor's attention is directed to the warranty obligations contained in the Article of the General Conditions of the specifications entitled "warranty".

3.12. OWNER TRAINING

- A. Upon completion of the project, furnish a complete copy of NFPA-25 to Owner. Provide correspondence indicating that the pamphlet has been turned over to the Owner.
 - 1. Contractor shall provide at least [eight (8)] hours of training to the Owner on the proper inspection, testing, and maintenance of the installed fire protection system.
 - 2. Schedule training with the Owner through the Architect and/or Engineer with at least seven (7) days prior notice.
 - 3. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1. GENERAL

1.1. SUMMARY

- A. All work under Division 22 is subject to the Division 01, General Requirements, the General Conditions and Supplementary Conditions.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all plumbing work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Submittals specified below. The right is reserved to make reasonable changes in location of equipment, piping, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 22 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.2. PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with the Division 01, General Requirements of the specification.

1.3. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors failure to do so.
- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct

locations.

1.4. CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 22 shall be fully qualified and acceptable to the Architect and Owner. Submit the following evidence when requested:
 - 1. A list of not less than five comparable projects which the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership in trade or professional organizations where required.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.5. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.6. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame

spread of 25 and smoke developed of 50.

1.7. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.
- B. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
- C. ASME - American Society of Mechanical Engineers
- D. ASPE - American Society of Plumbing Engineers
- E. ASTM - American Society for Testing and Materials
- F. AWWA - American Water Works Association
- G. ASME CSD-1 - American Society of Mechanical Engineers Controls and Safety Devices for Automatically Fired Boilers
- H. CAGI - Compressed Air and Gas Institute
- I. CS - Commercial Standard
- J. CSD - Control and Safety Devices
- K. DNREC - Delaware Department of Natural Resources and Environmental Control
- L. FM - Factory Mutual
- M. IBC - International Building Code
- N. IEEE - Institute of Electrical and Electronics Engineers
- O. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry
- P. NEC - National Electrical Code
- Q. NEMA - National Electrical Manufacturers Association
- R. NSF - National Sanitation Foundation
- S. TEMA - Tubular Exchanger Manufacturers Association
- T. UL - Underwriters' Laboratories
- U. All plumbing equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled Codes and Standards.

1.8. SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.
- B. After acceptance of Material and Equipment List, submit six (6) copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.
- C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.
- D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.
- E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.
- F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- I. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.9. SHOP DRAWINGS

- A. Prepare and submit shop drawings for all plumbing equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not

shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

- B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.
- D. Items and Systems
 - 1. Access Doors/Panels including layout and location
 - 2. Duplex Air Compressors
 - 3. Automatic Temperature Control System and Equipment as it relates to plumbing system
 - 4. Backflow Preventers
 - 5. Compressed Air Filters
 - 6. Compressed Air Regulators
 - 7. Compressed Air Drain Traps
 - 8. Compressed Air Quick Disconnects
 - 9. Coordinated Drawings
 - 10. Condensate Neutralizers
 - 11. Direct Buried Piping
 - 12. Domestic Water Expansion Tank
 - 13. Domestic Hot Water Heater
 - 14. Domestic Water Heaters
 - 15. Drain Valves
 - 16. Drip Pans
 - 17. Emergency Shower & Mixing Valves
 - 18. Fire Stopping - Methods and Materials
 - 19. Floor Drains

20. Gas Fired Domestic Water Heater
21. Hose Bibbs and Wall Hydrants
22. Identification System
23. In-Line Circulators
24. Material and Equipment List
25. Operations and Maintenance Manuals
26. Pipe Enclosures
27. Pipe Guides and Anchors.
28. Pipe Materials Including Itemized Schedule
29. Plumbing Fixtures & Trim
30. Preliminary Testing and Balancing Report
31. Pressure/Temperature Relief Valves
32. Pressure Regulating Valves
33. Pumps
34. Refrigerated Air Dryers (for compressed air systems)
35. Screenshots of ATC System Graphics
36. Strainers
37. Test Certificates
38. Thermal Insulation Materials Include Table Summary
39. Thermometers and Gauges
40. Thermostatic Mixing Valves
41. Trap Priming Station/Valves
42. Vacuum Breakers
43. Valves
44. Vibration Isolation Materials
45. Weatherproof Assembly Components

46. Wiring Diagrams, Flow Diagrams and Operating Instructions

- E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked Reviewed or Comments Noted. After the proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect.

1.10. SUPERVISION AND COORDINATION

- A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.
- B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, equipment, and other work performed under Division 22.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- D. Coordinate electrical work required under Division 22 with that under Division 26. Coordinate all work under Division 22 with work under all other Divisions.
- E. Supply services of an experienced (10 years minimum) and competent Project Manager to be in constant charge of work at site.
- F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.
- G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.
- H. Coordinate installation of large equipment requiring positioning before closing in building.

1.11. CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 22. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.
- B. Do not cut structural members without approval from the Architect or Engineer.

1.12. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs,

exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

- B. Where plumbing vents or other pipes penetrate roofs, flash pipe with Stoneman Stormtite, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.
- C. Furnish and install pitch pockets or weather tight curb assemblies where required.
- D. Furnish and install roof drains, curbs, and vent assemblies specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.13. CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 22. Perform work in accordance with requirements of other applicable Divisions of these specifications.
- B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.14. EXCAVATION AND BACKFILLING

A. GENERAL

- 1. Perform all necessary excavation, or installation of work under Division 22, in whatever materials or conditions encountered, using suitable methods and equipment.
- 2. Accurately establish required lines and grades and properly locate the work.
- 3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

- 1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
- 2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSH Guidelines.
- 3. Keep excavations dry. Protect excavations from freezing.

- C. Backfilling: (Refer also to other portions of the specifications)
 - 1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
 - 2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
 - 3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
 - 4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.15. DRIVE GUARDS

- A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.
- B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.16. VIBRATION ISOLATION

- A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, or piping to building structure. See Division 23 Section, Vibration Controls for HVAC, Plumbing and Fire Protection.

1.17. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.18. FASTENERS

- A. All fasteners located in public spaces including classrooms, corridors, lobbies, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

1.19. DEFINITIONS

- A. Approve - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. Furnish and install or provide means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- C. Contractor means the mechanical contractor and any of his subcontractors, vendors,

suppliers, or fabricators.

- D. Piping includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. Concealed means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space [or attic].
- F. Exposed means not installed underground or concealed as defined above.
- G. Invert Elevation means the elevation of the inside bottom of pipe.
- H. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. Review - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- J. Building Line: Exterior wall of building.

1.20. MINIMUM EFFICIENCY REQUIREMENTS

- A. All plumbing equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- B. All piping and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.
- C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- D. All plumbing devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.21. FUTURE ADDITIONS

- A. Where future additions are indicated, install all piping to account for future additions. Furnish and install shut-off valve in ceiling adjacent to future additions. Provide cap at the end of the piping. Arrange so that in the future the cap can be removed and shut-off valve opened to serve future addition without draining system. Install bypass with balance valve and shut-off valve on domestic recirc system. Balance to future flow rate and then shut the bypass balance valve.

1.22. SYSTEM INTEGRATION

- A. For all plumbing equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system, provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.

- B. Plumbing equipment submittals requiring system integration as defined above must identify all required system integration points.
- C. Plumbing equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.
- D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the plumbing equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to plumbing equipment being delivered to the project.
- E. Once the plumbing equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The plumbing equipment manufacturer's representative familiar with system integration and the ATC subcontractor familiar with programming must be present.
- F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the plumbing equipment systems' integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.
- G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record.

1.23. LEAD FREE REQUIREMENTS

- A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State requirements. Potable water systems shall also comply with NSF 61 – Annex G and NSF-372.

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

- A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 22 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 22. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 22.
- B. All electrical work performed under Division 22 shall conform to the applicable requirements of Division 26 and conforming to the National Electrical Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA & International Building Code.
- C. Provide wiring diagrams with electrical characteristics and connection requirements.
- D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

- E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.
- F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.
- G. Motors located in exterior locations, wet air streams and outdoors shall be totally enclosed weatherproof epoxy-treated type.
- H. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- I. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.
- J. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. MOTORS AND CONTROLS

- A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.
- B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG 1.
- C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.
 - 1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.
 - 2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR2 of the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
 4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.
 5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.
- D. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of plumbing equipment. When approved by the Engineer, deviations from the specifications will be permitted as follows:
1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.
 2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.
- E. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.
- F. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	PERCENT AT	MINIMUM POWER FACTOR
1HP and above to	85.5 percent		84 percent
1-½ HP	86.5 percent		85 percent
2HP	86.5 percent		85 percent
3HP	89.5 percent		86 percent
5HP	89.5 percent		87 percent

- G. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.
- H. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.
- I. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.
- J. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.3. MOTOR INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.
- C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

2.4. WIRING DIAGRAMS

- A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.
- B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.
- C. Provide wiring diagrams for all major plumbing items of equipment to electrical contractor and ATC subcontractor for coordination.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to the Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- D. 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.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- G. Do not install equipment or piping over electrical gear, electrical panels, motor controllers, and similar electrical equipment. Install equipment and piping to maintain clear space above and in front of all electrical components per the National Electric Code.

3.2. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.
- C. Concrete housekeeping pads and foundations shall be not less than 4 inches high and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record demonstration and training video recordings. Record each training module separately.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
- D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4. PROVISIONS FOR ACCESS

- A. The contractor shall provide access panels and doors for all concealed equipment, valves, strainers, dampers, filters, controls, control devices, cleanouts, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.
- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.
 - 1. Acoustical or Cement Plaster: Style B
 - 2. Hard Finish Plaster: Style K or L
 - 3. Masonry or Dry Wall: Style M
- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.
- F. Where access doors are installed in wet locations (i.e. toilet rooms, and similar spaces, etc.) provide aluminum access doors/frame.

3.5. PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 22 to their original condition.

- E. The preceding requirements apply to all work, whether exposed or concealed.
- F. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exposed piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.
- H. All exterior roof mounted equipment, piping and vents shall be painted to match roof in color as selected by Architect.
- I. All exposed piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.
- J. All exposed piping, equipment, etc., in Mechanical Rooms, Mezzanines, and Storage where PVC jacketed shall not require painting. Label and identify and color code as specified.

3.6. CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.
- B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of Service Company used.
- C. Maintain strainers and dirt pockets in clean condition.
- D. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- E. Leave systems clean, and in complete running order.

3.7. COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.
- B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.8. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt,

debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.9. OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
- C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.
- D. Do not use plumbing systems for temporary services or temporary conditioning during construction. Refer to Division 01 section "Temporary Facilities and Controls" for temporary plumbing during construction.
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

- A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
- B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as "Normally Open" or "Normally Closed" as required.
- C. All items of equipment, including motor starters and disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal). Equipment identification and room name or area served shall be on each panel.

- D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the Operations and Maintenance Manuals as hereinafter specified.
- E. All lines piping installed under this contract shall be stenciled with direction of flow arrows and with stenciled letters naming each pipe and service. Refer to Division 22 Section, Plumbing Piping, Fittings, Valves, Etc. Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.
- F. Submit list of wording, symbols, letter size, and color coding for plumbing identification. Submit samples of equipment identification cards, piping labels, labels, and valve tags to Engineer for review prior to installation.
- G. Provide at least 8 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section, Instrumentation and Controls of HVAC and Plumbing Systems.
- H. Contractor shall demonstrate Sequences of Operation of all plumbing equipment in presence of Owner's representative, Engineer, and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

- A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 22 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 07 Section, "Fire Protection, HVAC and Plumbing Penetration Firestopping".
- B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, "Fire Protection, HVAC and Plumbing Penetration Firestopping".
- C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.
- D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.
- E. Piping sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.
- F. Extend all floor sleeves through floor at least 2-inches above finished floor, caulk sleeve the entire depth and furnish and install floor plate.

3.12. RECORD DRAWINGS

- A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the General Conditions and Supplementary Conditions.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The contractor guarantees for a two year period from the time of final acceptance by the Owner.
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
 - 3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
 - 4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

- A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Operations and Maintenance Manuals.
- B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared six (6) hardcopies and one (1) electronic copy of the Operations and Maintenance Manuals and deliver these copies of the manuals to the

Owner. The manuals shall be as specified herein. The manuals must be approved and will not be accepted as final until so stamped.

- B. The manuals shall be bound in a three ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: Operations and Maintenance Manual Owens Campus Automotive Training Facility– Plumbing Systems. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.
- C. Provide the following data in the booklet:
1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 2. Catalog data on each piece of plumbing equipment furnished.
 3. Maintenance operation and lubrication instructions on each piece of plumbing equipment furnished.
 4. Complete catalog data on each piece of plumbing equipment furnished including approved shop drawing.
 5. Manufacturer's extended limited warranties on equipment including but not limited to water heaters, storage tanks, solar panels.
 6. Chart form indicating frequency and type of routine maintenance for all plumbing equipment. The chart shall also indicate model number of equipment, location and service.
 7. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
 8. Provide supplier and subcontractor's names, address, and phone number.
 9. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
 10. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass. .
 11. Copy of the approved balancing report for plumbing equipment/system.
 12. Access panel charts with index illustrating the location and purpose of access panels.
 13. Approved Health and Plumbing and Electrical Certificates.
 14. Start-up reports for equipment.

- 15. Insert color graphic with embedded parameters for ATC system into Record and Information Booklet.
- D. Submit Operations and Maintenance Manuals prior to the anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Operations and Maintenance Manuals reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:
 - 1. Complete Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.
- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, and piping in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer’s literature showing internal wiring.

3.17. PIPING SYSTEMS TESTING

- A. The entire new plumbing piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner’s representative and documented in writing.

SYSTEM	TEST PRESSURE
Domestic Water & Coil Drain Piping	100 psi
Sanitary Piping	As specified below
Compressed Air Piping	150 psi
Emergency Fixtures, Tempered Water	100 psig

- B. All gas piping shall be pressure tested in accordance with NFPA-54. Gas piping systems shall be proven tight under the following gauge pressures for a duration of four (4) hours:

SYSTEM	TEST PRESSURE
Gas Piping	100 psig

- C. All storm, waste, vent and water piping shall be tested by the Contractor and approved by the Engineer before acceptance. All storm, soil, and waste piping, located underground, shall be tested before backfilling. The costs of all equipment required for tests are to be included in the contract price.

- D. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest stack above or at the roof. The system shall hold this water for thirty (30) minutes without showing a drop greater than lynch. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes. All testing shall be in accordance with the local Plumbing Code and witnessed by the Plumbing Inspector or authority having jurisdiction.
- E. Upon completion of roughing-in and before setting equipment and fixtures, the entire new water piping system shall be tested at a hydrostatic pressure of not less than one hundred (100) pounds per square inch gauge and proven tight at this pressure. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.
- F. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the Operations and Maintenance Manuals.

3.18. EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

3.19. OUTAGES

- A. Provide a minimum of fourteen (14) days' notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.
- B. Submit Outage Request form, attached at end of this Section, to Owner for approval.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE -- TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____

(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ___ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ___ NO: ___ NAME: _____

SECTION 220505 - PLUMBING PIPING, FITTINGS AND VALVES

PART 1. GENERAL

1.1. SUMMARY

- A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 22 Section, Common Work Results for Plumbing and Division 01, General Requirements.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.
- B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and International Building Code (IBC).
- C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- F. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.
- G. Use spring loaded "silent" check valves on discharge of all pumps.
- H. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- I. At all runout piping serving equipment, use swing joints with elbows to prevent excessive movement of piping due to expansion.

1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating

approval of welders.

- C. Welders Certification: In accordance with ASME Section 9.
- D. 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.
- E. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
- F. Maintain one copy of each document on site.

1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.6. EXTRA MATERIALS

- A. Provide one (1) repacking kit for each size valve.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.8. LEAD FREE REQUIREMENTS

- A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State of Delaware requirements.

1.9. PLASTIC PIPE PENETRATIONS

- A. Install UL listed collars, sealing methods, and firestopping at all plastic pipe penetrations of smoke walls and fire rated walls per NFPA.

PART 2. PRODUCTS

2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.
1. Sanitary Underground - Within Building to 5 Feet Outside of Foundation Wall
 - a. PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 2. Sanitary and Vents Above Floor Inside Building:
 - a. PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 3. Indirect Waste Piping:
 - a. Pipe & Fittings: Hard drawn Type L copper tubing with cast brass drainage fittings. ASTM B88-78 and ANSI B16.1877. All exposed indirect waste piping shall be chrome plated or primed and painted with silver paint.
 4. Domestic Cold Water Outside of Building Below Ground or Under Building to Point 5 Feet from Building Line:
 - a. Pipe: 2-1/2 inches & smaller, soft temper type K. ASTM B88 - No joints below grade except as approved by the Engineer.
3 inches & larger, ductile iron pipe for water, ANSI 21.50 & 21.51 with double thickness cement mortar lining, ANSI 21.4.
 - b. Fittings & Joints: wrought copper solder joint fittings, ANSI B16.22. Joints for copper piping shall be ASTM B32, SOLDER, grade 95TA. Cast iron pressure fittings, ANSI 21.10, Class 250. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings ANSI A21.11. Joints for ductile iron pipe shall be AWWA C111, rubber gasket with 3/4 inch diameter rods.
 5. Domestic Hot, Cold, Recirculating, and Emergency Fixture Tempered Water, Water Piping Inside Buildings, Above Grade:
 - a. Pipe or Tubing: 2 inches & smaller, all water lines soft temper Type K copper tubing below ground, hard temper Type L copper tubing above ground, ASTM B88, or Type 304/304L, Schedule 10S, stainless steel to ASTM A312.
2-1/2 inches & larger, hot dipped galvanized steel A120, ASTM A53, Grade B, Schedule 40 steel, or hard copper tube, Type L with copper-tube dimensioned grooved ends; copper ground - end fittings; copper tubing, keyed couplings; and grooved joints. (Flaring of tube or fitting ends to

accommodate alternate sized couplings is not permitted.)

Provide dielectric fittings between steel and copper. Victaulic Style 47 or approved equal.

- b. Fittings & Joints: Copper tubing fittings and joints shall be solder type wrought copper - 95-5 silver solder or braze (lead and antimony based solders are prohibited). Galvanized steel pipe fittings and joints shall be ANSI B16.12 hot dipped galvanized threaded ends and 125 lb. galvanized cast iron fittings or 150 lb. galvanized malleable iron.
 - i. Stainless steel fittings shall be Vic-Press or approved equal for Schedule 10S pipe. Fittings shall be precision, cold drawn, stainless steel with EPDM O-ring seals. (Seals shall be UL classified in accordance with ANSI/NSF61 for Potable Water service.) Fittings rated for working pressures to 500-psi.
 - ii. Grooved joint couplings shall consist of two ductile iron housing segments cast with offsetting angle pattern bolt pads, FlushSeal elastomer gasket, and ASTM A449 electroplated steel bolts and nuts. (Gasket shall be UL classified in accordance with ANSI/NSF61 for Potable Water service, and shall meet the lead content requirements of NSF-372.) Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 607H or approved equal.
 - iii. Installation-Ready™ fittings for grooved end copper tubing shall be manufactured to copper-tube dimensions. Fittings shall be ductile iron conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, complete with PVDF (Poly Vinylidene Fluoride) and Grade “EHP” EPDM-HP (Grade ‘T’ Nitrile) gasket; and ASTM A449 electroplated steel bolts and nuts. System shall be rated to 300 psi (2065 kPa) with Type K or L Copper Tubing.
 - 1) UL classified in accordance with NSF-61 for potable water service. The system shall meet the low-lead requirements of NSF-372.
- c. Gate Valves: 2-1/2 inches & larger - OS&Y, IBBM flanged, 125 lb. standard solid wedge.
 - i. 2 inches & smaller - bronze solder end, bronze body, solid wedge, rising stem, 200 lb. w.o.g. non-shock. However, use brass valves only on all copper pipe.
- d. Butterfly Valves: Cast brass body to UNS C87850, elastomer pressure responsive seat, aluminum-bronze disc with stainless steel stem. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Copper-tube dimensioned grooved ends, suitable for working pressures to 300-psig CWP Victaulic Style 608N or approved equal.
- e. Ball Valves: Shut-off valves 2-inches and smaller shall be ball valves. Ball valves shall be 150 lbs, brass or bronze body, standard port, 2 piece body, TFE seats with bronze trim. Ball valves shall be threaded end or solder end, or Vic-Press end as required to accommodate piping. Ball valves shall be as manufactured by Victaulic, Conbraco, Crane, Apollo, Nibco, Watts or engineer approved equal.
- f. Unions: 2-1/2 inches & larger - 150 lb. brass companion flanges.
 - i. 2 inches & smaller - wrought copper, ground joint solder ends;

- threaded hexagonal stainless steel union with Vic-Press ends, Victaulic P589 or approved equal.
- g. Check Valves: 2-1/2 inches & larger - IBBM, 125 lb. std. flanged bronze swing check, with metal disc; 2-inches and smaller - 125 lb. std. screwed or solder ends.
 - h. Globe Valves: 2 inches and smaller, bronze body, bronze trim, rising stem, hand wheel, inside screw, renewable composition disc, solder ends, 150 lb, with back seating capacity.
 - i. 2 inches & larger: IBBM, 150 lb, bronze trim, rising stem, handwheel OS&Y, plug type disc, flanged ends, renewable seat and disc.
 - ii. Globe valves shall be Conbraco, Crane, Nibco, Milwaukee, Watts or approved equal.
 - i. Combination Shut-off/Balancing Valves:
 - i. Victaulic/TA Hydronics, Taco Circuit Setter, Bell & Gossett Circuit Setter Plus, Flowset Accuset, Gerand, or engineer approved equal, ½ inch-3 inches 300 psi rated globe type or ball valve with DZR brass Ametal (copper-alloy) or bronze body/brass ball construction with glass and carbon filled TFE seats, in-line flow meter and balancing and shut-off valve with built in ball valve for flow adjustment. Valve shall have memory stop, calibrated nameplate, Schrader valve connections and preformed molded insulation. Valves shall be leaktight at full rated working pressure. Balance valve size shall be selected based on manufacturer's acceptable flow range and design flow rate. Pressure drop through combination shut off balance valves shall not exceed 5 feet of head at design flow rate.
 - j. Extended Valve Stems: Provide and install round collar type extended valve stems on all valves installed in insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve handles outside of insulation.
 - k. (Alternate): At contractor's option, Viega ProPress pressure seal mechanical fittings may be utilized.
 - i. Viega, ProPress Pressure Seal Fittings: Bronze, or copper shall conform to ASME B16.51, ICC LC 1002, IAPMO PS 117, NSF 61, and NSF 61-G or NSF 372. ProPress fittings ½-inch thru 4-inch for use with ASTM B88 copper tube type L and ½-inch up to 1-1/4-inch annealed copper tube. ProPress fittings shall have an EPDM sealing element grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) feature.
6. Gas Piping:
- a. Pipe: Inside Building Above Ground: Schedule 40 uncoated black steel pipe, ASTM A53 or A120.
 - b. Outside Building, Below Ground: Copper type L tubing, ASTM B88 Below Ground.
 - c. Outside building above grade/roof: Schedule 40 black steel pipe, ASTM A53 or A120.
 - d. Fittings & Joints: 150 lb. screwed malleable iron ASTM B16.3 with joints sealed with litharge and glycerin. Piping 2 ½ inches and larger and any

concealed piping within walls must be welded, ASTM A24 forged steel welded type joints shall be threaded or welded to ANSI B31.1 or ASME Sec. 1.

- e. Plug Valves: 2- ½ inches & larger ASME B16.38 and MSS SP-78 cast iron lubricated plug valves with 125 psig pressure rating, 3 turn type. Gas valves are prohibited above ceilings.
- f. Cocks: 2 inches & smaller - bronze, Crane 270. AGA certified bronze body, plug type with bronze plug, ball type with chrome plated brass ball, for 5 psig or less gas. Include AGA stamp, flat or square head or lever handle, and threaded ends conforming to ASME B1.20.1
- g. Ball Valves: Full flow, double seal, ball type with bronze body, Buna-N seals and O-ring packing, chrome plated brass ball and designed for working pressures up to 175 psig. Valves shall be 3 turn type. MSS SP-78, class 175 WOG.
- h. Gas Vents: Install vent piping for gas pressure regulators and gas trains, extend outside building to a non-hazardous location away from any potential source of ignition, and vent to atmosphere. Pipe material shall be identical to gas piping here-in before specified. Terminate vents with turned down, reducing elbow fittings with corrosion-resistant insect screen in large end.
- i. Finish: All gas piping downstream of regulator and installed exposed shall be primed and finished with two coats of rust resistant paint with pewter gray finish. Paint shall be two part epoxy-exterior paint as manufactured by Pittsburgh Paint, Themeco, or approved equal. Painting shall be provided under another Section of these Specifications.

7. Shop Compressed Air Piping:

- a. Pipe: Standard weight steel pipe, Schedule 40, black, ASTM A53 or A120; or Schedule 10S stainless steel, ASTM A312, with plain ends.
- b. Fittings & Joints: 250 lb ASME B16.3 malleable iron fittings or ASTM A234, forged steel welding type. Joints shall be threaded or welded to ANSI B31.1 or ASME Section 1 requirements.
- c. Stainless steel fittings shall be Vic-Press or approved equal for Schedule 10S pipe. Fittings shall be precision, cold drawn, stainless steel with HNBR O-ring seals. Fittings rated for working pressure to 500-psi.
- d. Ball Valve: Victaulic Series P569, Worcester ball valve Type X-411T, approved equal.

8. Gas Fired Condensing Water Heating Condensate Piping

- a. Piping shall be PVC pipe, ASTM D1785 schedule 40 with ASTM D2466 socket fittings for schedule 40. Join PVC pipe/fittings utilizing solvent cement ASTM D2564 with ASTM F 656 primer.
- b. Provide backwater valve (ball float type) at connections of condensate piping to stormwater piping and air gap fitting. Backwater valve shall be Model Z1099 as manufactured by Zurn or approved equal. Backwater valve shall have drain coated cast iron body, plastic ball float, bronze backwater bushing and replaceable neoprene seat.

B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or

Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

- C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.
- D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS, ROLLER SUPPORTS, ANCHORS, GUIDES, AND SADDLES

- A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260, Carpenter and Patterson, or approved equal for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
¾ & 1	6	5	3/8
1 - ½	6	8	3/8
2	8	8	3/8
2 - ½	10	9	½
3	12	10	½

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
4	14	12	5/8
5	14	12	5/8
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8
12	20	18	7/8

- B. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.
- C. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
- D. Hangers for cold pipe sizes 2 inches (50 mm) and over: Carbon steel, adjustable, clevis.
- E. Hangers for cold pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
- F. Hangers for cold pipe sizes 6 inches (150 mm) and over: adjustable steel yoke, cast iron

- roll, double hanger.
- G. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.
 - H. Multiple or Trapeze hangers for hot pipe sizes 6 inches (150 mm) and over: Steel channels with welded spacers and hanger rod, cast iron roll.
 - I. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook
 - J. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp.
 - K. Wall support for hot pipe sizes 6 inches (150 mm) and over: welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 - L. Vertical Support: Steel riser clamp.
 - M. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - N. Floor support for hot pipe sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - O. Floor support for hot pipe sizes 6 inches (150 mm) and over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 - P. Copper pipe support: Carbon steel ring, adjustable, copper plated.
 - Q. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - R. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3. VALVES

- A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer.
- B. Check valves in circulator discharges shall be horizontal type.
- C. Multi-purpose valve (non-slam check valve, throttling valve, shut-off valves and calibrated balancing valve) shall be provided at discharge side of each constant speed pump. The valve shall be of heavy-duty cast iron construction with standard ANSI flanged connections and rated for a maximum working pressure of 175 psig at 240oF. The valve shall be fitted with a stainless steel stem or stem sleeve and brass seat with "O" ring seal. Valve shall be Taco "Plus One" Number 300-4.2, Bell and Gossett 3DS Triple Duty Valve, Armstrong, or as approved equal, and shall have check and plug valve features plus a memory stop with pointer and scale. Provide additional shut-off valve to allow servicing of check valve if a multipurpose valve is utilized in lieu of separate check, shut-off, and balance valve. Provide additional shut-off valve downstream of multi-purpose valve to allow servicing of multi-purpose check valve feature. Provide pre-manufactured, removable insulation

covers for all multipurpose valves.

2.4. STRAINERS

- A. Strainers shall be of the basket or "Y" type and shall be heavy and durable, constructed of best grade gray iron with the bottoms drilled and plugged. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and brass sediment baskets made of brass not less than #22 gauge in thickness. Total area of basket perforations shall be not less than four times the cross section of the entering pipe. Flow shall be into basket, and then out through the perforations. Strainers shall be suitable for water or the intended fluid. Strainers 2 inches and smaller shall have threaded or solder ends, 2 inches and larger shall have flanged ends.
- B. Strainer screens shall be stainless steel with perforations and shall be 1/16-inch for pipe sizes 5 inches and less, 1/8-inch (40 percent open area) perforations for pipe sizes 6-inch and greater.
- C. Provide valved and capped (with chain) blowdowns in each strainer. Blowdown valves shall be Appolo 78-100/200 series or as approved equal.
- D. Strainers shall be manufactured by Watts, Mueller, Armstrong, Yarway, Spirax/Sarco or as approved equal.

2.5. UNIONS, FLANGES, AND COUPLINGS

- A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.
- B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.
- C. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, and slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.
- D. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.6. MANUAL AIR VENTS

- A. Manual air vents shall be similar to the hereinafter specified gauge valves. Provide 1/4-inch size on 3/4-inch pipe and smaller, 1/2 -inch size on 1-inch pipe and larger. Install at all high points of piping. Valves shall be Crane No. 88, or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.7. THERMOMETERS

- A. Unless otherwise indicated, thermometers shall be ASTM E1, in a glass type, organic filled, 9-inch scale size, corrosion-resistant metal case, with "any-angle" mounting with positive locking device. Trerice Industrial Thermometers, Weksler Instruments, Ernst Gage Co., Miljoco, or approved equal. Insertion stem length shall suite the pipe size and configuration. Thermometer wells shall be brass with brass union hubs in copper and in

ferrous piping. Where piping is insulated or otherwise covered, use wells with lagging extension. Where wells are installed in pipe tees at turns, increase pipe size so that well does not restrict flow. Accuracy shall be 2 percent.

- B. Unless otherwise indicated, thermometer ranges shall be as follows:
 - 1. Tepid water and Domestic cold water: 0 degrees F to 100 degrees F, 1 degrees F Division.
 - 2. Domestic hot and hot water recirculating: 30 degrees F to 180 degrees F, 2 degrees F Division.
 - 3. Tempered Water: 30 degrees F to 100 degrees F, 2 degrees F Division.
- C. Provide heat conducting compound in wells.

2.8. PRESSURE GAUGES

- A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.
- B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.
- C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.
- D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.
- E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.9. PIPING SPECIALTIES

- A. Furnish and install flexible pipe connections, as specified and/or shown on the drawings, at suction and discharge connections of all in-line pumps, connections to air compressors, all vibrating equipment and elsewhere as shown. Pump flexible connections shall be utilized at pumps. Refer to Division 23 Section, Vibration Control for HVAC, Plumbing and Fire Protection Equipment for specifications.
- B. Pressure relief valves shall be provided in the number and sizes required to relieve 110

percent of the full input to the systems. Valves shall be rated; and installed in accordance with ASME, and CSD-1 including all amendments. Pipe discharge full size to floor drain, (with union) and support discharge pipe to prevent exerting any strain on relief valve body, piping to be Type-L copper. Water safety relief valves shall be Watts Series 740, Conbraco, Series 154A, Bell and Gossett, or approved equal. Provide pressure gauge adjacent to all safety relief valves.

- C. Gas relief valve piping shall be sized and installed in accordance with the latest edition of ASME Boiler & Pressure Vessel Code, CSD-1 including amendments. Pipe material shall be as specified for gas piping. Gas relief valve piping material shall be the same as hereinbefore specified for gas piping.

2.10. ESCUTCHEONS

- A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.
- B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.11. DIELECTRIC CONNECTIONS:

- A. Furnish and install electrically insulated dielectric unions, waterway fittings, or flanges, as manufactured by Victaulic Company, EPCO Sales, Inc., at the following locations:
 - 1. Where steel piping systems join copper piping.
 - 2. Where copper tube connects to domestic water storage tanks, water heaters, heat exchangers, expansion tanks, and other steel vessels.
 - 3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.
 - 4. Dielectric Waterway: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. UL classified in accordance with NSF-61 for potable water service, and shall meet the low lead requirements of NSF-372. Basis of Design: Victaulic Series 647.

2.12. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.
- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend 3/4-inch above the floor. Refer to Division 23

Section, Vibration Controls for HVAC, Plumbing and Fire Protection Equipment for mechanical equipment room penetrations additional requirements. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.

- C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.
- D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.13. PRESSURE REDUCING VALVES

- A. Provide pressure reducing valves as indicated, of size and capacity selected by the installer to maintain operating pressure on the system. Body shall be cast-iron or bronze construction, renewable stainless steel seat, non-corrosive disc, water tight cage assembly, adjustable pressure ranges and inlet strainer Watts Regulator Model 223-S, Armstrong, Bell and Gossett or as approved equal.
- B. Provide pressure gauge adjacent to all pressure reducing valves to verify proper set point.

2.14. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees F.

2.15. GAS PRESSURE REGULATORS

- A. Gas pressure regulators shall be as manufactured by Equimeter, Inc., Maxitrol Co., Rockwell, Fisher Controls, American Meter Co., or approved equal. Gas pressure regulators shall maintain a constant downstream pressure with a variable inlet pressure.
- B. Gas pressure regulators shall comply with ANSI Z21.18 and shall be single stage, steel jacketed, corrosion-resistant type. Include atmospheric vent, elevation compensator, with threaded ends conforming to ASME B1.20.1 for 2 inch NPS and smaller and flanged ends for 2 ½ inch NPS and larger.
- C. Each pressure regulator shall have an identification stamped on diaphragm cover and shall be painted AGA grey. Regulator inlet and outlet pressures, and flow volume in cubic feet per hour of specified gas are as indicated on the contract drawings.
- D. Regulators installed exposed outside shall be designed and listed for outside installation.

2.16. FLEXIBLE GAS PIPE CONNECTIONS

- A. Description: Comply with AGA LC 1 and include the following:

1. Tubing: Corrugated stainless steel with plastic jacket or coating.
2. Fittings: Copper alloy with ends made to fit corrugated tubing. Include ends with threads according to ASME B1.20.1 if connection to threaded pipe or fittings is required.
3. Striker Plates: Steel, designed to protect tubing from penetrations.
4. Manifolds: malleable iron or steel with protective coating. Include threaded connections according to ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
5. Available Manufacturers:
 - a. OmegaFlex, Inc.
 - b. Titeflex Corp.
 - c. Tru-Flex Metal Hose Corp.
 - d. Ward Industries, Inc.

2.17. TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.
- D. Plastic-to-Metal Transition Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.

- c. Spears Manufacturing Company.
2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.
- B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.
- C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.
- D. All valves, strainers, caps, and other fittings shall be readily accessible.
- E. Rough-in and final connections are required to all equipment and fixtures provided under this Contract.
- F. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.
- G. Discharge lines from all relief valves shall be piped to within 4-inches of floor and extend to floor drains wherever floors are not pitched to drains. Pitch the relief valve piping away from the relief valve to issue that no fluid can be trapped in valve discharge. Support all relief valve piping to prevent exerting strain on the relief valve body. The end of the relief valve discharge piping shall not be threaded to prevent capping or plugging.
- H. All branches from water mains shall be taken from the top of the supply mains at an angle

of forty-five (45) degrees above the horizontal, unless otherwise directed. Branches feeding down shall be taken from the side or bottom of the main on water mains only. All connections shall be carefully made to insure unrestricted circulation, eliminate air pockets or trapped condensate, and permit the complete drainage of the system.

- I. Cutoff valves shall be provided on each branch line from the mains on all plumbing lines.
 - J. Shut-off valves shall be installed at the inlet and outlet of each piece of equipment to permit isolation for maintenance and repair.
 - K. Balancing valves shall be installed in all domestic re-circulating systems and at all pumps, and where indicated on the drawings.
 - L. Unions shall be installed on all bypasses, at all connections to equipment, where shown on drawings or where required to facilitate removal of equipment whether shown or not.
 - M. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.
 - N. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.
 - O. Install all valves with stem upright or horizontal, not inverted.
 - P. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.
 - Q. Provide clearance for installation of insulation and access to valves and fittings.
 - R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
 - S. All water containing pipes shall be routed clear of combustion air dampers and louvers to prevent freezing condition when dampers are open.
 - T. Provide manual air vents at top of piping systems.
 - U. Where access doors are required, install piping so that valves can be grouped together to minimize the quantity of access doors.
 - V. Install manufactured U.L. listed firestop collars at all floor/wall penetrations for all PVC and CPVC pipe penetrations.
- 3.2. THERMOMETER AND PRESSURE GAGE INSTALLATION REQUIREMENTS.
- A. Install thermometers and adjust vertical and tilted positions.
 - B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to one-third diameter of pipe.
 2. Fill sockets with oil or graphite and secure caps.
- C. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.
- D. Adjust faces of thermometer and gages to proper angle for best visibility.
- E. Clean windows of thermometer and gauges and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. 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.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. 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.
- F. Examine grooved ends for form and cleanliness. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
- G. Do not attempt to repair defective valves; replace with new valves.
- H. Install valves as indicated, according to manufacturer's written instructions.
- I. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- J. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- K. Locate valves for easy access and provide separate support where necessary.
- L. Install valves in horizontal piping with stem at or above the center of the pipe.
- M. Install valves in a position to allow full stem movement.
- N. Adjust or replace packing after piping systems have been tested and put into service, but

before final adjusting and balancing. Replace valves if leak persists.

3.4. COMPRESSED AIR PIPING INSTALLATION

- A. Compressed air piping shall be installed in accordance with the American Society of Plumbing Engineers recommendations. To prevent build-up of moisture, all compressed air piping shall be pitched in the direction of flow, with drain valves installed at low points. Slope piping a minimum of one inch per 40 Ft., and provide manual shut-off valve.
- B. Install take-offs to outlets from top of main, with shut-off valve after take-off. Slope take-off piping to outlets. Provide drain leg and drain trap at end of each main, branch, and low point in piping.
- C. Install compressed air couplings, female quick connectors, regulators and pressure gauges where outlets are indicated.
- D. Install tees instead of elbow at changes in direction of piping. Fit open end of each tee with plug.
- E. Connect condensate drains to nearest floor drain. Unless otherwise noted all condensate drain piping shall be copper type "L".
- F. Install eccentric reducers where pipe is reduced in size in direction of airflow, with bottoms of both pipes and reducer flush.

3.5. WASTE AND VENT PIPING INSTALLATION REQUIREMENTS

- A. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. All pipe when laid shall rest on the full length of the barrel and bell holes shall be dug in trench bottoms to make joints. Pipe shall not be adjusted to grade by use of block or wedges. Where rock or old foundations are encountered, trenches shall be excavated 6-inches below grade and crusher run limestone shall be used as a bedding material to support barrel of pipe.
- B. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description.
- C. Trenches shall be kept free from water until the pipe jointing material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At all times, when work is not in progress, all open ends of pipe and fittings shall be securely closed to the satisfaction of the Engineer, so that no trench water, earth or other substance will enter the pipe or fittings.
- D. Slip joints will be permitted only in trap seals or on the inlet side of the trap. Unions on the sewer side of the trap shall be ground faced, and shall not be concealed or enclosed. Install bell and spigot pipe with bell end upstream.
- E. Threaded joints shall be American Standard taper screw threads with permacel joint

compound applied to the male thread. Connections between threaded pipe and cast iron pipe shall have a ring or half coupling screwed on to form a spigot end on the threaded pipe.

- F. Establish invert elevations, slopes for drainage to 1/8 inch per foot. Maintain gradients.

3.6. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. **Welded Joints:** Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.
- B. Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.
- C. **Grooved Joints:** 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.)
- D. **Screwed Joints:** All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.
- E. **Soldered Joints and Copper Piping:** Joints in copper piping shall conform to the following minimum standards.
 - 1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
 - 2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
 - 3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
 - 4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.

5. Solder joints shall be made by using a direct flame from a torch.
 6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
 7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
 8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
 9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.
- F. Where copper piping joins steel piping, approved bronze adapters shall be used.
- G. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.
- H. When installing gas piping which is to be concealed (i.e., in walls), unions, tube fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combination of fittings shall not be used. All concealed piping within walls shall be welded.
1. Gas Piping
 2. Final Gas Connections: Unless otherwise specified herein, final connections shall be made with rigid metallic pipe and fittings.
 3. Pipe Joints:
 - a. Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.
 - b. Threaded Metallic Joints: Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.
 - c. Welded Metallic Joints: Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.
 - d. Thermoplastic Joints: Jointing procedures shall conform to AGA 01. Solvent cement or heat of fusion joints shall not be made between different

- kinds of plastics.
- e. Joining Thermoplastic to Metallic Piping: When compression-type mechanical joints are used, the gasket material in the fittings shall be compatible with the plastic piping and with the gas in the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting, and the stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. A split tubular stiffener shall not be used.
 - f. Special Requirements; Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall comply with NFPA 54.
 - g. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches (100mm) outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.
 - h. Install gas meter per manufacturer's requirements.
 - i. Install metal shut-off valves upstream and downstream of gas meter with full size normally closed bypass valve.
 - j. Install strainer on inlet of gas meter.
- I. Plastic piping solvent cement joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
- 1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. PVC Piping: Join according to ASTM D2855.

3.7. HANGERS AND SUPPORTS INSTALLATION REQUIREMENTS

- A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal.
- B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.
- C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.
- D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by

suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.

- E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.
- F. Select hangers and components for loads imposed. Secure rods with double nuts.
- G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.
- H. Support overhead piping with clevis hangers.
- I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.
- J. Refer to structural documents for appropriate connection/attachment materials to building.

3.8. AIR VENTING INSTALLATION REQUIREMENTS

- A. The top of each plumbing piping system and other points as indicated or where necessary for the removal of air from the system or equipment, shall be vented using an approved type of manual air vent.
- B. In addition to manual air vents at high points of system, each item of water heat transfer equipment shall be manually vented using an approved type manual air vent. All air vents shall be accessible.

3.9. DIRT POCKETS INSTALLATION

- A. Dirt pockets shall be installed at the base of all risers and ahead of all gas equipment and as indicated on the drawings.

3.10. EXPANSION LOOPS AND SWING CONNECTION INSTALLATION REQUIREMENTS

- A. Install expansion fittings according to manufacturer's written instructions.
- B. Install expansion fittings in sizes matching pipe size in which they are installed.
- C. Align expansion fittings to avoid end loading and torsional stress.
- D. Install pipe bends and loops cold sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- E. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written

instructions.

- F. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- G. Connect risers and branch connections to plumbing equipment with at least four pipe fittings, including tee in riser.
- H. Connect mains and branch connections to plumbing equipment with at least four pipe fittings, including tee in main.

3.11. PIPING IDENTIFICATION REQUIREMENTS

- A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.
- B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.12. VALVE IDENTIFICATION REQUIREMENTS

- A. All valves shall be tagged with a numbered tag.
- B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.
- C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size,

manufacturer and service.

- D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in each mechanical equipment room including each air handling unit mechanical equipment room. Additional copies shall be provided in each copy of the O&M manuals.

3.13. CLEANING PIPING AND EQUIPMENT

- A. All water, plumbing piping, and pumped condensate systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water purged of all air.
- B. All water, plumbing, and pumped condensate piping system shall be flushed clean with fresh water. See Division 22 Sections, Plumbing Fixture and Plumbing Equipment for domestic potable water cleaning and sterilization.

3.14. PRESSURE SEAL FITTING INSTALLATION REQUIREMENTS

- A. Viega, ProPress Pressure Seal bronze, or copper fittings: Sealing element shall be verified for the intended use. Tube ends shall be cut on a right angle (square) to the tube. Tube ends shall be reamed and chamfered, all grease oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting. Utilizing a Viega Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the tube fully into the fitting and mark the tube wall at the face of the fitting. Always examine the tube to ensure it is fully inserted into the fitting prior to pressing the joint. ProPress fittings shall be installed according to the most current edition of the Viega installation guidelines. Installers shall attend a Viega ProPress installation training class.
- B. After ProPress Pressure seal fittings have been installed a “two step test” shall be followed. Pressurize the system with application appropriate test medium, water between 15 and 85 psi, or air/dry nitrogen between .5 and 45 psi. Check the pressure gauge for pressure loss. If the system does not hold pressure, walk the system and check for un-pressed fittings. Should you identify an un-pressed ensure the tube is fully inserted into the fitting and properly marked, prior to pressing the joint. After appropriate repairs have been made, retest the system per local code, or specification requirements, not to exceed 600 psi with water or 200 psi when using air.

END OF SECTION

SECTION 220701 - PLUMBING INSULATION

PART 1. GENERAL

1.1. REFERENCE

- A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 22 Section, Common Work Results for Plumbing.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2. DESCRIPTION

- A. All piping and equipment installed under this Contract shall be covered as specified.

1.3. SCOPE

- A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to all piping, equipment, and systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.4. STANDARDS

- A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or use:
 - 1. American Society for Testing of Materials Specifications:
 - a. ASTM C 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation".
 - b. ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation".
 - c. ASTM C 55, "Standard Specification for Mineral Fiber Blanket and Felt Insulation".
 - d. ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Materials".
 - e. ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)".
 - f. ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation".
 - g. ASTM C 1136, "Standard Specification for Barrier Material, Vapor, "Type 1 or 2 (Jacket only)".
 - h. ASHRAE 90.1 "Energy efficient design of new buildings except low-rise residential buildings", latest edition.
- B. Insulation materials, including all weather and vapor barrier materials, closures, hangers,

supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.5. SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers' Association (NAIMA) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. As minimum, all insulation thicknesses shall be as hereinafter specified.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:
 - 1. American Society for Testing of Materials ASTM E 84
 - 2. Underwriters' Laboratories, Inc. UL 723
 - 3. National Fire Protection Association NFPA 255
- C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.6. QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.
- C. Mockups:

Provide at project site a sample of each type of insulation hereinafter specified. Display insulation in an "installed" condition, showing typical completed pipe, covers, fittings, ductwork and equipment insulation. No insulation shall be applied until these samples have been accepted by the Engineer. Any insulation work which does not conform to the accepted samples will not be acceptable, and shall be removed and re-installed in a manner acceptable to the Engineer at no additional cost to the Owner. Build mockups according to the following requirements, using materials indicated for the completed work.

- 1. Include the following pipe insulation mockups:
 - a. Exterior aluminum jacketing
 - b. One 10-foot section of NPS 2 inch straight pipe.

- c. One 90-degree elbow.
 - d. One tee fitting.
 - e. One NPS 2 inch valve.
 - f. Four support hangers, including hanger shield and insert.
 - g. One strainer with removable portion of insulation.
 - h. One reducer.
2. Include the following equipment insulation mockups:
 - a. One backflow preventer.
 - b. One small tank or vessel.
 - c. One plumbing pump/circulator.
 - d. Make-up Valve body.
 3. Mockups shall include samples of both concealed insulation and exposed insulation.
 4. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
 5. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
 6. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
 7. Obtain Engineer approval of mockups before starting insulation application.
 8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 9. Demolish and remove mockups when directed.
 10. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.7. DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following

exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer in writing for technical assistance.

- D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.8. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. GENERAL

- A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.2. PIPE INSULATION MATERIALS

- A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with "K" rating of .23 at 75 degrees F mean temperature, for service temperatures between -60 degrees F and +450 degrees F with all service poly-encapsulated jacket. Pipe insulation shall be fiberglass ASJmax SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.
- B. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Foster 85-20/85-50 or Childers CP-82 (5 gallon cans only) adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.
- C. For fittings on all piping, valves, and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Cold piping: Apply a tack coat of vapor barrier coating and reinforcing mesh. After ½ hour, apply second coat of same vapor barrier coating, UL labeled, Type C, for cold water piping. Hot piping Type H for hot water piping: Apply tack of breather mastic. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of breather mastic over the reinforcing cloth, working it to a smooth finish. As an option to the above hot fittings, a polyvinyl chloride fitting cover may be supplied.
- D. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as

listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.

- E. For piping having a vapor barrier insulation and for all insulated piping requiring supports, hangers and supports shall be installed outside the insulation. Wherever hangers and supports are installed outside the insulation, pipe insulation protecting shields shall be provided. Where insulation is a load bearing material, of sufficient strength to support the weight of the piping, pipe shields one-third the circumference of the insulation and of a length not less than three times the diameter of the insulation (maximum length 24-inches) shall be provided. Insulation of 7-1/4 pound or greater density will be considered as load bearing for pipe sizes up to and including 2-inches. Where insulation is not of sufficient strength to support the weight of the piping, a half section of high density fiberglass or foam inserts, shall be provided. Vapor barrier and finish shall be applied as required to match adjoining insulation. In addition, shields shall be furnished as specified above.
- F. For piping located outside of the building, a corrugated aluminum weatherproof jacketing system shall be provided. This system shall be Micro-Lot ML as manufactured by Manville, Polyweld by Pabco Metals Corp., Childers, or as approved equal, and installed per the manufacturer's recommendations. Where outdoor piping is receiving electric heat tape, the insulation shall be oversized so that the heat tape is not compressed tightly to the pipe. Pipe jacketing shall be corrugated (3/16-inch) deep aluminum, .016-inch thickness of H-14 temper with aluminum strapping of .75-inch width and .020 inch thickness with moisture barrier. Aluminum jacketing elbows shall be smooth, .016-inch thickness and 1100 alloy. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Longitudinal joints shall be applied so they will shed water and shall be sealed completely and shall be sealed completely with metal jacketing sealant. Sealant shall be Foster 95-44 or Childers CP-76. Circumferential joints shall be closed using preformed butt strips following manufacturer's recommendations for securement. Jacket seams shall be located on the bottom side of the horizontal piping.
- G. On cold systems such as domestic cold water, rainleaders, vapor barrier performance is extremely important. All penetrations and seams of the ASJ and exposed ends of insulation must be sealed with vapor barrier coating. The ASJ must be protected with either a vapor barrier coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion. Vapor Barrier Coating: Foster 30-65; Childers CP-34 or Vimasco 749. Permeance shall be 0.03 perms or less at 45 mils dry at test by ASTM E96.
- H. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of Fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape, solvent weld adhesive and appropriate fasteners.
 - 1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends

shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvac jacket with ends that secure to adjacent piping.

2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
 3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation.
- I. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.
1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hangers saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.
 2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding +_200 degrees F (93 degrees C), Owens-Corning Pink or IIG, Calcium Silicate pipe insulation shall be used for high density inserts.
 3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).
 4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
 5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
 6. On vertical runs, insulation support rings shall be used.

2.3. PIPING INSULATION THICKNESSES SCHEDULE

- A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	THICKNESS
All Drain Piping from Cooling Coils/Evaporators	1-inch thickness
All Domestic Hot and Cold Water Piping , including Re-circulating Piping	1-inch thickness
All Above Grade Floor Drain Piping Serving AHU Condensate Drains include Drain Sumps and Auxiliary Drain Pipes from Auxiliary Pans	1-inch thickness
Above Grade Trap Priming Lines	½ -inch thickness
Electric Water Cooler Drains	1-inch thickness
Emergency Fixture Tepid Water Piping	1-inch thickness

2.4. EQUIPMENT INSULATION MATERIALS AND THICKNESSES

A. The following equipment shall be insulated with Fiberglass Rigid Board Insulation or Foam Plastic Insulation:

1. Expansion Tanks.
2. Backflow Preventer Valve Bodies.
3. Plumbing Pumps.
4. All Pump Volutes and Strainers.
5. All piping within emergency and high-low mixing valve cabinets.
6. Make-up Water Valve Bodies

B. Insulation for cold surfaces shall be 1-1/2-inch thickness, 6 lb. density, 705 FRK with a "K" rating of .23 at 75 degrees F mean temperature. Insulation for hot surfaces except as otherwise noted shall be 1-1/2-inch thickness, 6 lb. density, 705 with a "K" rating of .23 at 75 degrees F mean temperature. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be 1-inch by 25 gauge galvanized steel spaced on not over 12-inch centers. All joints and voids shall be filled with Owens-Corning #110 cement, well troweled into openings. For 705 FRK insulation, all joints and voids shall be FRK taped and vapor sealed. There shall be applied over the insulation surface 1-inch galvanized wire netting laced together at all edges and wired to the steel bands with 16 gauge soft annealed wire. Over this shall be applied 2-inch thick layer of Owens-Corning #110 cement applied in two layers. Install metal corner beads at all corners and edges in order to provide a permanent installation. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 or Childers CP-50AMV1 lagging adhesive at the rate of 60-70 square feet per gallon. Embed into wet

coating a layer of 8 ounce canvas smoothed out to avoid wrinkles and lap all seams a minimum of 2-inches. Apply a second brush coat of Sealfas 30-36 or Childers CP-50 AMV1 lagging adhesive to the entire surface at the rate of 60-70 square feet per gallon. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum at least 0.040 inch (1.0 mm) thick.
3. For below ambient services, install a vapor barrier coating at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.

E. Support rings shall be provided to support the top head insulation where required.

F. Outdoor installations require a weather barrier mastic for protection of the insulation jacketing.

G. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

2.5. ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.
3. Support Materials - Hanger straps, hanger rods, saddles.
4. Fasteners, weld pins/studs, speed clips, insulation washers.
5. Metal mesh or expanded metal lagging.

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.6. FIELD-APPLIED JACKET

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer. VOC content not to exceed 250 g/L.
 - 3. Color: High Gloss White
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 5. Factory-fabricated tank heads and tank side panels.

PART 3. EXECUTION

3.1. WORKMANSHIP

- A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.2. SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and

physical properties.

3.3. PREPARATION

- A. Ensure that all pipe and equipment surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping systems has been completed prior to installing insulation.

3.4. INSTALLATION

A. Piping Systems

1. General:

- a. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
- b. Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
- c. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
- d. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures and other penetrations of the pipe insulation vapor barrier coating.
- e. On exposed piping, locate insulation and cover seams in least visible location.

2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:

- a. Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
- b. Insulation cement equal in thickness to the adjoining insulation.
- c. PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

4. Joints:

- a. Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.
- b. All pipe insulation ends shall be tapered and sealed, regardless of service.

B. Equipment Insulation:

1. General:

- a. Install insulation in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
- b. Install insulation on equipment after installation of heat tracing, painting, testing, and acceptance tests.
- c. Install insulation materials with smooth, even surfaces. Rework poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer installation, applying each layer of insulation separately.
- d. Coat insulated surfaces where specified on contract drawings with layer of insulating cement, troweled in a workmanlike manner, leaving a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.
- e. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. Seal all tears, punctures and other penetrations of equipment insulation facing.
- f. Where specification calls for field-applied all-service vapor barrier jacketing, it shall be neatly fitted and tightly secured. Lap seams 2-inches (5cm) (min.). Seal all joints with adhesive. Tape with 3-inches (7.5cm) matching pressure-sensitive tape or 3-inch (7.5cm) glass fabric and vapor barrier coating.
- g. On exposed equipment, locate insulation and cover seams in least visible location.

2. Removable Insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, such as vessel covers, fasteners, flanges, frames accessories, manholes, handholes, cleanouts ASME stamp, and manufacturer nameplates.

3. Areas Left Uninsulated: Items such as manholes, handholes, clean-outs, ASME stamp, and manufacturers' nameplates should be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, provide removable insulation and appropriate tagging to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

4. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather barrier mastic protective finish or jacketing as recommended by the jacketing manufacturer.

3.5. FIELD QUALITY ASSURANCE

- A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.6. PROTECTION

- A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.
- B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.7. SAFETY PRECAUTIONS

- A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.
- B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.8. INSULATION COVERING

- A. Unless otherwise noted, all exposed equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over equipment insulation. PVC shall be high gloss white and shall be 20 mils thick. Exposed areas include, but are not limited to, all mechanical equipment rooms/fan rooms, mezzanines, penthouses, boiler rooms, janitor's closets, electric rooms, and piping and ductwork exposed in an occupied space.
- B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, white high gloss, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 20 mils, roll stock ready for shop or field cutting and forming.
- C. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

END OF SECTION

SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Town of Georgetown Design and Construction Standards for Water, Sewer, and Streets, Latest Edition.

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service mains.
- B. Water distribution piping shall be installed to within five (5) feet of the edge of proposed building foundations, unless specifically noted elsewhere in the contract documents.
- C. Contractor shall furnish and install all mains, hydrants, valves and fittings as specified and indicated on the drawings.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure Ratings: Except where otherwise indicated, the following are minimum pressure requirements for water system piping.
 - 1. Underground Piping: 160 psi (1103 kPa).1
- B. Protection of Potable Water Supply:
 - 1. A minimum of 10 feet horizontal separation shall be provided between proposed water mains and proposed sewers.
 - 2. Clearances: Where specified crossing clearance cannot be obtained, sewer shall be encased in concrete for 10 feet each side of water main. For crossings of other utilities, sewer shall be encased with limits of the utility trench.
 - a. Sewer crossing water mains shall have a clearance of 18 inches below water main or shall be encased.
 - b. Sewers shall have a minimum of 6 inches clearance when crossing other utilities.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

- C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- D. Field quality-control test reports.
- E. Record drawings at Project closeout of installed water system piping and products according to Division 1 Section "Project Closeout."

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping.
 - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.
- G. Provide listing/approval stamp, label, or other marking on equipment made to specified standards
- H. Off-site water main infrastructure shall comply with Artesian Water Company Standards.
- I. Water main infrastructure shall comply with Ten States Standards and State of Delaware Office of Drinking Water requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. There is not current water supply or service to the site. Contractor to provide for all water necessary for construction.
- B. Site Information: Reports on subsurface condition investigations made during the design of the Project are available for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions (between soil borings). Owner and Architect assumes no responsibility for interpretations or conclusions drawn from this information

1.8 COORDINATION

- A. Coordinate connection to Building Plumbing and other Division 22 work.
- B. Coordinate with other utility work including but not limited to fire protection systems piping.
- C. Coordinate electrical requirements of actual equipment furnished with requirements specified in Division 26.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, latest edition and shall be Class 50 cement-lined with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Mechanical-Joint, Ductile-Iron Fittings: ANSI/AWWA C153/A21.53 and C111/A21.11 with a 350 psi pressure rating. Ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, Class 50 cement-lined with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
 - C. Flanges: ASME 16.1, Class 125, cast iron.
 - D. Comply with NFPA 24 and local/state regulations for fire-service mains.
- 2.2 PVC PIPE AND FITTINGS
- A. PVC, AWWA Pipe: AWWA C900, Pressure Class 235, DR 18 with bell end with gasket, and with spigot end.
 - B. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 1. Gaskets: AWWA C111, rubber.
 - C. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - D. Mains & Services for Fire Suppression
 1. Comply with UL 1285 for fire-service mains if indicated.
 2. Comply with NFPA 24 and local/state regulations for fire-service mains.
- 2.3 PE PIPE AND FITTINGS
- A. PE, AWWA Pipe: AWWA C901 & NSF Standard 14, DR 9 PE3608; with PE compound number required to give pressure rating not less than 200 psig.
 - B. PE, AWWA Pipe: AWWA C906, ASTM F-714 and NSF Standard 14, DR No. 9 (200 psi) or DR No. 11 (160 psi).
 1. PE, AWWA Fittings:
 - a. 3" and larger: AWWA C906, butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than adjoining piping. Mechanical fittings are also acceptable with stiffener insert.
 - b. Less than 3": Compression fittings only. Stiffener inserts required.

2.4 COPPER PIPE

- A. Type K Copper Pipe, Standards ASTM B88, B306, B280, & B819, Compliance Certified For Use In Potable Water Applications, Max. Pressure Rated 435 psi.

2.5 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

- B. Split-Sleeve Pipe Couplings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Romac Industries, Inc., 501 ductile iron coupling, or approved equal.
- 2. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
 - a. Standard: AWWA C219.
 - b. Sleeve Material: Stainless steel.
 - c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
 - d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
 - e. Pressure Rating: 200 psig minimum.
 - f. Metal Component Finish: Corrosion-resistant coating or material.

2.6 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Provide valves by Waterous, Mueller Co. or a comparable product approved by the Engineer.
- 2. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig .
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.

2.7 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:

- 1. Manufacturers: Provide products by one of the following:

2. Provide FAST model by Ford Meter Box Co., or approved equal.
3. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange, manufactured by Kennedy.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, extra deep lid with two holes, adjustable extension of length required for depth of burial of valve (valve boxes shall be adjustable between 2'-4" and 3'-4" except when deeper settings are required) , plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel 5 1/4 inches in diameter.

1. Provide boxes by Mueller, or a comparable product approved by the utility.
2. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
3. All boxes for 4, 6, and 8-inch valves shall be equipped with #6 round base. Valve boxes shall be adjustable between 2'-4" and 3'-4" except when deeper settings are required.

2.8 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ford Meter Box Company, Inc.; Kennedy; per utility company standard.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Stainless Steel with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 5 1/4 inches in diameter Buffalo screw type. Valve boxes shall be Tyler Union 6850 series, two-piece valve boxes with standard base.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.9 IDENTIFICATION

- A. Metallic-Lined Plastic Underground Warning Tapes: Polyethylene plastic tape with metallic core, 6 inches (150 mm) wide by 4 mils (1 mm) thick, solid blue in color with continuously printed caption in black letters "CAUTION - WATER LINE BURIED BELOW."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. On-site Underground Water-Service piping shall be any of the following:
 1. PE, AWWA C906 Pressure Class 160 SDR 11 Pipe for domestic water service as noted on the drawings.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults as indicated in utility company details. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
 2. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
 3. Relief Valves: Use for water-service piping in vaults and aboveground.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General Locations and Arrangements: Drawings 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 except where deviations to layout are approved on coordination drawings.
- B. Install piping at indicated slope.
- C. Install restrained joints for buried piping within 5 feet (1.5m) of building. Use restrained-joint pipe and fittings, thrust blocks, anchors, tie-rods and clamps, and other supports at vertical and horizontal offsets.
- D. Install piping free of sags and bends.
- E. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- F. Install fittings for changes in direction and branch connections.

3.5 PIPING INSTALLATION

- A. Make connections NPS 2 and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement as indicated on the drawings.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.
- B. Comply with NFPA 24 for fire-service-main piping materials and installation.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
 - 2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- D. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- E. Bury piping with depth of cover over top at least 42 inches, with top at least 12 inches below level of maximum frost penetration.
- F. Pipe cover can be temporarily reduced to 36 inches over the water pipe to clear another utility at a crossing with Owner approval.

- G. 8-inch diameter Tyton Push-Joint ductile-iron pipes can be deflected a maximum of 5 degrees or 19-inches per 18-foot pipe length vertically & horizontally (effectively a 205-foot radius without bends).
- H. A 2-inch blow-off is to be installed on the ends of mains.
- I. Installation shall comply with Ten States Standards, State of Delaware Office of Drinking Water requirements and Town of Georgetown Standards.
- J. Each section of pipe shall be placed on a solid foundation for its full length, with recesses excavated to accommodate the bell of the pipe. Any pipe which has its grade or joint disturbed after installation shall be removed and reinstalled. No pipe shall be installed on frozen or wet subgrade. Bedding material shall be provided, if required, by the Architect.
- K. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench, and shall be kept clean during laying operations by means of plugs or other approved methods. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench or weather conditions are unsuitable for such work.
- L. At all times work is not in progress, all open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substance will enter the pipe or fittings.
- M. Any section of pipe in place and found to be defective shall be removed and replaced immediately at no cost to the Owner.
- N. No section of pipe shall be installed with deflection greater than manufacturer's recommendations either vertically or horizontally. Any deviation required to be greater than recommended shall be made with a special fitting.
- O. All installation of ductile iron pipe shall be in accordance with AWWA Standard No. C600 with detector tape.
- P. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping to within 5, of building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- Q. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- R. See Division 21 Section "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.
- S. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:

1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
 2. Set-screw mechanical retainer glands.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 2. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE & VALVE BOX INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- C. Valve boxes shall be installed at each outside valve. Boxes shall be sufficient length to provide a cover of not less than two feet over the pipe. Valve boxes shall be set plumb, and placed directly over the valve. Valve boxes shall be placed on two, 4-inch solid concrete blocks. After being correctly positioned, each fill shall be carefully tamped around the valve box for a distance of four (4) feet on all sides of the box. Any box found out of plumb or settled shall be reset at no cost to the Owner.

3.9 FIELD QUALITY CONTROL

- A. Piping Tests: The Contractor shall furnish all equipment, labor, and materials, including water, pumps, compressors, stopwatch, gauges, and meters as approved by the Project Civil Architect for testing. The Project Civil Architect shall determine the amount of main to be tested at anyone time and reserves the right to separate the installation into several test sections. All tests must be witnessed by the Project Civil Architect or Owner.
- B. Domestic Water Main Hydrostatic Tests: Test at not less than one-and-one-half times working pressure or 100 psi, whichever is greater, for two hours.
 1. Test Pressure shall:
 - a. Be of at least two hour duration

- b. Not vary by more than \pm five psi.
- 2. Pressurization:
 - a. Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of the lowest point of the line or section under the test and corrected to the elevation of the test gauge shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Owner.
- 3. Air Removal:
 - a. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points, so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, all corporation cocks shall be removed and plugged, or left in place at the discretion of the Owner.
- 4. Examination:
 - a. All exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test shall be repaired or replaced with same material and the test shall be repeated until it is satisfactory to the Owner.
- C. Leakage Test: A leakage test shall be conducted concurrently with the pressure test.
 - a. Leakage Defined: Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or at any valved section thereof, to maintain pressure within five psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.
 - b. Allowable Leakage: No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{ND \text{ square root of } P}{7400}$$

in which L is the allowable leakage, in gallons per hour, N is the number of joints in the length of pipe line tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test in pounds per square inch gage.

Allowable leakage at various pressures is shown in Table I (appearing after this Subsection).

- c. When hydrants are in the test section, the test shall be made against the closed hydrant.

- d. Should the tests show the main to be defective, the Contractor shall remedy such defects and retest the main as specified above. This procedure shall be repeated until the test requirements are met.

TABLE I

Allowable Leakage per 100 feet of Pipeline* - gph						
Avg. Test Pressure psi	Nominal Pipe Diameter - Inch					
	2	3	4	6	8	10
150	0.18	0.28	0.37	0.55	0.74	0.92
125	0.17	0.25	0.34	0.50	0.67	0.84
100	0.15	0.23	0.30	0.45	0.60	0.75

**For pipe with 18-ft nominal lengths. To obtain the recommended allowable leakage for pipe with 20-ft nominal lengths, multiply the leakage calculated from the table by 0.9. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.*

- D. Test fire suppression piping according to NFPA 24, as directed by the fire suppression contractor and local authorities
- E. Prepare reports of testing activities.

3.10 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 2. Use purging and disinfecting procedure prescribed the Delaware Department of Health. Procedure shall be as described in AWWA C651.
 3. If method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Upon completion of water main construction, disinfect main and appurtenances. Disinfection shall be done in accordance with ANSI/AWWA C-651, latest edition. Contractor shall submit a plan of disinfection for approval by the Architect.
 - b. After the applicable retention period, the heavily chlorinated water shall be flushed from the main. This water shall be discharged to the sanitary sewer system. Only after water leaving the main is no higher in chlorine concentration than normal drinking water, will a discharge to storm drains be allowed. Convey flushed water to discharge point in a closed system.
 - c. Affidavits of compliance, certifying the water sampled from the water mains to be free of coliform bacteria, shall be submitted to the Architect. The Contractor is

responsible for requesting tests from the Delaware Department of Public Health. He shall provide written documentation when a section of mains can be placed in service.

- d. The Contractor shall place in each length of pipe, hydrants, hydrant branches, and other appurtenances, a sufficient amount of HTH tablets to insure adequate disinfection treatment of the main after its completion. Tablets shall be fastened to the inside top of every length of pipe as laid, using gasket cement known as "Permatex No. 2".
- e. The Contractor will be held entirely responsible for securing a minimum residual chlorine content of 5 p.p.m. at the extremities of the mains after twenty-four (24) hours or more contact with the full water pressure on the main.
- f. Water for filling the mains shall be introduced at a velocity of less than one (1) foot per second in order to permit the HTH or Perchloron to completely dissolve and have a reasonable uniform distribution throughout the mains. It is the intent of this Specification to require a sufficient amount of chemical to be equivalent to a dosage of 50 p.p.m. of chlorine.
- g. After the chlorine has been in contact with the mains or storage units for twenty-four (24) hours or longer, samples collected from the extremities of the mains shall indicate a residual chlorine content of 5 p.p.m. or more.
- h. If less than 5 p.p.m. residual chlorine is indicated, the system shall be drained and the disinfection treatment repeated.
- i. If samples collected at the extremities indicate a residual chlorine of 5 p.p.m. or more, the system shall be flushed until there is only a normal chlorine residual (1.0 p.p.m. or less) present, as determined by the DPD Method Test. Samples of water shall be collected from various points along the lines, by a lab certified in the State of Delaware for bacteriological analysis. If satisfactory bacteriological results are obtained, the lines may then be allowed to be placed in service. A copy of all test results shall be submitted to the Architect.

4. Contractor shall provide all disinfection testing within the lump sum prices bid.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

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SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Town of Georgetown Design and Construction Standards for Water, Sewer, and Streets, Latest Edition.

1.2 SUMMARY

- A. This Section includes gravity-flow, non-pressure sanitary sewerage outside the building, with the following components:

- 1. Special fittings for expansion and deflection.
- 2. Cleanouts.
- 3. Precast concrete manholes.
- 4. Pipe

- B. All water and wastewater utility construction and materials to be dedicated to the Town shall be performed by a contractor approved by the city and to the standards and specifications issued by the town. This includes review and approval by the town of shop drawings and materials. Comply with the *Town of Georgetown Design and Construction Standards for Water, Sewer, and Streets, Latest Edition*.

C. SUBMITTALS

- D. Product Data: For the following:

- 1. Special pipe fittings.
- 2. Bedding materials

- E. Shop Drawings: For the following:

- 1. Manholes: Include plans, elevations, sections, details, and frames and covers.
- 2. Pipe and fittings

- F. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary sewerage systems.
- B. Utility Compliance: Comply with local Municipality/utility company regulations and standards pertaining to sanitary sewer systems.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Municipality no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Municipality's written permission.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that sewerage system piping may be installed in compliance with original design and referenced standards.
 - 1. Locate existing sanitary sewerage system piping and structures that are to be abandoned and closed.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 GRAVITY PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM D-1860, elastomeric seals. Pipe stiffness, as tested in accordance with ASTM-D-2412, shall be 45 when measured under 5% deflection at 73° Fahrenheit. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding 20.0 feet.
- B. Corrugated PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 949-93a, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- C. Polyvinyl chloride wye branches, pipe stoppers and other fittings shall be manufactured in accordance with the same specifications and shall have the same thickness, depth of socket, and annular space as the pipe. Tee fittings will not be permitted for use. Wye branches shall be complete pipe sections. Saddles will not be permitted for use.
- D. Polyvinyl chloride pipe shall be delivered and stockpiled in unit pallets. Stacking of pallets above five (5) feet in height will not be allowed. If pipe is stockpiled for more than thirty (30) days prior to installation in the trench, it must be suitably covered with reflective material to protect the pipe from ultraviolet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.
- E. Bowed sections of pipe will be unacceptable and installation of pipe which has bowed, whether or not the bow has been corrected, will not be allowed.
- F. Couplings: Rubber or elastomeric sleeve and stainless steel band assembly fabricated to match outside diameters of pipes to be joined.
 - 1. Sleeves: ASTM C 564, rubber for cast-iron soil pipe; and ASTM F 477, elastomeric seal for plastic pipe. Sleeves for dissimilar or other pipe materials shall be compatible with pipe materials being joined.
 - 2. Bands: Stainless steel, one at each pipe insert.

2.3 CLEANOUTS

- A. Wye & Riser: Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
- B. Cover: Geneco Cleanout Cap or approved equal.

2.4 MANHOLES

A. General

- 1. Manholes shall be State of Delaware Department of Transportation certified.
- 2. Manholes shall be built at such points on the pipelines, and of such form and dimensions as are shown on the drawings or as may be directed. Manholes shall be built as pipe laying progresses, and the Project Civil Engineer may stop work entirely on the pipe laying, if manhole construction is delayed to such an extent as to be hazardous to construction or the public.
- 3. Manholes shall be spaced no more than 400 feet apart and at all bends in gravity sewer mains.

B. Precast Concrete Manholes: ASTM C 478, precast reinforced concrete, of depth indicated with provision for rubber gasket joints.

- 1. Precast reinforced concrete risers, eccentric cones and bases shall be in conformance with ASTM Designation C 478. Joints between riser sections shall be fitted with an "O" ring rubber gasket, meeting the requirements of ASTM Designation C 443. Installation of risers shall be in accordance with manufacturer's recommendations under the supervision of the Architect.
- 2. Precast reinforced concrete base and riser sections shall be as manufactured by Atlantic Precast Corporation, or equal.
- 3. Interior and exterior joint spaces of all manhole risers shall be filled prior to application of the exterior waterproofing. The interior joint shall be mortared. The exterior joint may be mortared or filled with a joint filler compound. Said compound shall be Pioneer 301 as manufactured by Daubert Chemical Company, Oakbrook, Illinois, or equal.
- 4. Lifting holes in the walls of precast reinforced concrete risers will be allowed but shall be plugged with rubber stoppers and grouted flush with face or manhole wall after installation of manhole riser sections. Not more than two (2) holes shall be cast in the walls of each riser section for the purpose of handling.
- 5. The exterior surface of all precast manholes shall receive a minimum two (2) coat application of a 68% solids coal tar type protective coating. The total average dry film thickness shall measure 24 mils with no single measurement to be less than 20 mils. Surface shall be prepared in accordance with the manufacturer's instructions and coatings applied in the field in a manner acceptable to the Project Civil Engineer. The coating material shall be Bitumastic Super Service Black manufactured by Koopers Company, Inc., Pittsburgh, Pennsylvania, Tar Jet Super Black XX-32-B-22 manufactured by Pennsbury Coatings Corp., New Britain, Pennsylvania, or equal.
- 6. All pipe-to-manhole connections in the precast manhole shall be made by means of an integrally cast flexible connector which shall be Lockjoint flexible manhole sleeve as manufactured by Interpace Corp., Parsippany, New Jersey, or A-Lok flexible manhole gasket as manufactured by A-Lok Corp., Trenton, New Jersey, or equal meeting requirements of ASTM C-923.
- 7. Channel and Bench: "SS" Sewer brick with care taken to secure smooth and even surfaces with full special mortar joints. Manhole channels may be factory cast with prior approval from the Town.

C. Manhole Steps: Wide enough for a man to place both feet on one step and designed to prevent lateral slippage off the step.

- 1. Material: Manhole steps shall be made of 3/8-inch diameter (No. 3) steel reinforcing bars, ASTM Designation A 615, Grade 60, encased in polypropylene plastic. Manhole steps shall have notched tread ridge with retainer lug on each side.

2. Manhole steps shall be cast in place during manufacture of precast reinforced concrete manholes or placed in brick manholes during construction. Embedment length shall be suitable for minimum five (5)-inch thick, precast reinforced concrete riser walls.
3. Manhole steps shall be OSHA approved and as manufactured by; M.A. Industries, Inc., Peachtree City, Georgia; ICM, Inc., Jacksonville, Arkansas, or equal.
4. Manhole steps shall be spaced twelve (12)-inches apart. The maximum spacing from top of manhole to the first step shall not exceed sixteen (16)-inches.

D. Manhole Frames and Covers:

1. Frames and covers shall be as manufactured by EJ, model 1045 watertight assembly; or Model R-1642, self-sealing application as manufactured by Neenah Foundry. They shall be heavy duty, with machined seats, inner cover and bronze lock lugs. Material for frames and covers shall be in accordance with standard specifications for gray iron castings ASTM A-48 for Class 35.
2. Frames and covers for manholes shall be set by the Contractor as the work progresses. The frame shall be well bedded in mortar.
3. The maximum allowable vertical adjustment of manhole cover frames shall be 12 inches. Adjustments shall be made with brick and mortar or precast adjustment rings may not be used.
4. Covers shall be marked "SANITARY SEWER" and two pick holes cast into cover.

E. TESTS

1. If inspection reveals any visible leakage or seepage in any manhole, the Contractor will be required to accomplish such remedial measures as may be directed by the Project Civil Engineer. Caulking or patching of interior manhole surfaces will not be acceptance.

2.5 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 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: 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 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: Match pipe slope through manhole.
2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.

2.6 IDENTIFICATION

- A. Metallic-Lined Plastic Underground Warning Tapes: Polyethylene plastic tape with metallic core, 6 inches wide by 4 mils thick, solid green in color with continuously printed caption in black letters "CAUTION - SEWER LINE BURIED BELOW."
- B. Tracer wire:
 - 1. Minimum 12 gauge green coated solid copper wire.
- C. MODIFIED EPOXY COATING
 - 1. Tnemec Series 435 or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall contact the Town of Georgetown Public Works Department Director at (302) 856-6045 prior to start of construction.

3.2 PREPARATION OF FOUNDATION FOR BURIED SANITARY SEWERAGE SYSTEMS

- A. Grade trench bottom to provide a smooth, firm, stable, and rock-free foundation, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials at the surface upon which bedding and pipes are to be laid, and backfill with clean sand or pea gravel to indicated level.
- C. Shape bottom of trench to fit bottom of pipe. Bottom of Trench to include a continuous and uniform bedding of #57 stone with a minimum depth according to Town of Georgetown Standards and Specifications. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

3.3 INSTALLATION, GENERAL (GRAVITY)

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of the underground sanitary sewerage system piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.
- E. Install piping pitched down in direction of flow, at minimum slope of 2 percent, except where indicated otherwise.

- F. Extend sanitary sewerage system piping to connect to building sanitary drains, of sizes and in locations indicated.
- G. Install 1-inch-thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12 inches beyond each side of pipe. Install directly over and center on pipe center line.
- H. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed, by tunneling, jacking, or a combination of both.
- I. Manhole stubs shall be extended four (4) feet outside of the manhole wall, unless otherwise detailed. The stub end shall be plugged.

3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION (GRAVITY)

- A. Join and install hub and spigot cast-iron soil pipe and fittings with compression gaskets in accordance with CISPI "Cast Iron Soil Pipe and Fittings Handbook, Volume I." Use "Extra Heavy" class gaskets to match class of pipe and fittings.
- B. Join and install PVC pipe as follows:
 - 1. Pipe and gasketed fittings, joining with elastomeric seals in accordance with ASTM D 3212. Bell and spigot pipe.
 - 2. Installation in accordance with ASTM D 2321.
- C. Join different types of pipe with standard manufactured couplings and fittings intended for that purpose.

3.5 MANHOLES

- A. General: Install manholes complete with accessories as indicated. Form continuous concrete or split pipe section channels and benches between inlets and outlet. Set tops of frames and covers flush with finish surface where manholes occur in pavements. Elsewhere, set tops 3 inches above finish surface, unless otherwise indicated.
- B. Place precast concrete manhole sections as indicated, and install in accordance with ASTM C 891.
- C. Construct cast-in-place manholes as indicated.
- D. Provide rubber joint gasket complying with ASTM C 443 at joints of sections.
- E. Apply bituminous mastic coating at joints of sections.

3.6 CLEANOUTS

- A. Install cleanouts and extension from sewer pipe to cleanout at grade as indicated. Set cleanout frame and cover in concrete block 18 by 18 by 12 inches deep, except where location is in concrete paving. Set top of cleanout 1 inch above surrounding earth grade or flush with grade when installed in paving.

3.7 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work.

- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of 3000-psi 28-day compressive-strength concrete.
- C. Make branch connections from side into existing 4- to 21-inch piping by removing section of existing pipe and installing wye fitting, into existing piping. Encase entire wye with not less than 6 inches of 3000-psi 28-day compressive-strength concrete.
- D. Make branch connections from side into existing 24-inch or larger piping or to underground structures by cutting opening into existing unit sufficiently large to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or 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.
 - 1. Provide concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - 2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.
- E. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWERAGE SYSTEM

- A. Abandoned Piping: Close open ends of abandoned underground piping that is indicated to remain in place. Provide sufficiently strong closures to withstand hydrostatic or earth pressure that may result after ends of abandoned utilities have been closed.
 - 1. Close open ends of concrete or masonry utilities with not less than 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. Wood plugs are not acceptable.
- B. Abandoned Structures: Remove structure and close open ends of the remaining piping, or remove top of structure down to not less than 3 feet below final grade; fill structure with stone, rubble, gravel, or compacted dirt, to within 1 foot of top of structure remaining, and fill with concrete.

3.9 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground Sewerage piping. Locate 6 to 8 inches below finished grade, directly over piping.

3.10 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. Flush piping between manholes and other structures to remove collected debris.
 - 2. Place plug in end of incomplete piping at end of day and when work stops.
- B. The Project Civil Engineer shall be notified in advance of all tests, and all tests shall be conducted to his entire satisfaction.

- C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: According to mandrel test.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- D. 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. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 3. Submit separate report for each test.
 4. Sanitary Sewerage: Perform air test according to UNI-B-6 and the Town of Georgetown Standards and Specifications.
 5. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- E. MANDREL TEST:
1. Sanitary sewer pipe shall be deflection tested not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling an approved solid pointed mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the inside diameter of the pipe. The mandrel shall be a rigid, nonadjustable mandrel having an effective length of not less than its nominal diameter.
 2. Testing shall be conducted on a manhole to manhole basis and shall be done after the line has been completely cleaned and flushed. Any portion of the sewer which fails to pass the test shall be excavated, repaired or realigned and retested with both air and deflection tests.
- F. LEAK TESTING USING AIR:
1. Procedures:
 - a. Sewers shall be tested in sections of not more than 400 foot lengths unless otherwise approved by the Project Civil Engineer. Each section shall be tested immediately upon completion thereof. Each section shall meet the air pressure drop limitations specified herein.
 - b. All material and labor required for leakage tests shall be furnished by the Contractor.
 - c. Sewers shall be tested using the low-pressure air method in accordance with the requirements of ASTM C-828 and the Uni-Bell Plastic Pipe Association recommendations, based upon the Ramseier test time criteria. Procedural and equipment details shall be submitted to the Project Civil Engineer prior to acceptance of its use for testing.
 - d. A pressure of 4 psi shall be maintained for five (5) minutes with no variation.
 - e. If the pressure drops before the appropriate test time has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test. Contractor shall determine, at his own expense, the source or sources of leakage and he shall repair or replace all

defective materials and/or workmanship to the satisfaction of the Project Civil Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

2. Leaks and loss in test pressure constitute defects that must be repaired.
3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

G. VIDEO INSPECTIONS

1. Televiser all sewer lines and manholes per the Municipality's requirements.
2. All video inspections shall be performed utilizing the NASSCO PACP methodology.
3. Video inspection reports shall be reviewed by the Architect and Municipality representative.
4. If the video inspection shows any defects, Contractor shall replace all defective materials and/or workmanship to the satisfaction of the Architect and Municipality. The completed pipe installation shall then be retested and required to meet the requirements of this test.

H. FORCEMAIN TESTING

1. Piping Tests: The Contractor shall furnish all equipment, labor, and materials, including water, pumps, compressors, stopwatch, gauges, and meters for testing. The City shall determine the amount of main to be tested at anyone time and reserves the right to separate the installation into several test sections. All tests must be witnessed by the Owner's Representative and Municipality.
2. Force Main Hydrostatic Tests: Test at not less 75 psi, for two hours with no variation.
3. Copies of testing results must be submitted to Architect and Municipality.

I. TRACER WIRE AND IDENTIFICATION TAPE VERIFICATION

1. Provide tracer wire and identification tape verification according to the City's Water/Wastewater Handbook, section V. F.

END OF SECTION 221313

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SECTION 221343 - FACILITY PACKAGED SEWAGE PUMPING STATIONS

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 multiple, complete factory-built and tested, combined Wetwell/Drywell Grinder Pump Stations, consisting of duplex grinder pumps suitably mounted in a basin constructed of Fiberglass Reinforced Polyester Resin with dimensions and capacities as show on the Contract Drawings, NEMA 6P electrical quick disconnect (EQD), pump removal system, stainless steel discharge assembly/shut-off valve, anti-siphon valve/check valve, each assembled in the basin, electrical alarm panel and all necessary internal wiring and controls. Component type grinder pump systems that require field assembly will not be acceptable due to the potential problems that can occur during field assembly.

1.3 PERFORMANCE REQUIREMENTS

- A. The pumps shall be capable of delivering 15 GPM against a rated total dynamic head of 0 feet (0 PSIG), 11 GPM against a rated total dynamic head of 92 feet (40 PSIG), and 7.8 GPM against a rated total dynamic head of 185 feet (80 PSIG). The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.
- B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Show fabrication and installation details for each packaged sewage pumping station. Detail equipment assemblies and indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Pump Control Panel:
 - 3. Provide ballast / buoyancy calculations for each pump station assuming groundwater 1' below ground surface.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates submitted for:
 - 1. Packaged pump station.
 - 2. Control Panel

- B. Warranty: As a certification requirement, Contractor shall provide with their submittals a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump MANUFACTURER, which certifies a minimum of a 24-month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the MANUFACTURER will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance type requirements shall be included in this form as exclusions. These requirements include, but are not limited to, unjamming of grinder mechanism, periodic motor maintenance, and periodic cleaning of liquid level controls. Should the CONTRACTOR (supplier) elect to submit a performance bond in lieu of the experience clause outlined above, this Warranty Performance Certification shall also be used as a criterion to evaluate the CONTRACTOR'S (supplier's) performance over the warranty period. A Warranty Performance Certification form is included with the bid schedule and must be completed and submitted as part of the bid package. Bids with incomplete forms or missing forms will be considered nonresponsive.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (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 HI 1.1-1.2, "Centrifugal Pumps for Nomenclature and Definitions"; HI 1.3, "Centrifugal Pumps for Design and Application"; and HI 1.4, "Centrifugal Pumps for Installation, Operation and Maintenance," for sewage pumps.

- E. Comply with UL 778, "Motor-Operated Water Pumps," for sewage pumps.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to any existing user unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:
 - 1. Notify Engineer no fewer than seven (7) days in advance of proposed interruption of sanitary sewer service.
 - 2. Do not proceed with interruption of sanitary sewer service without Engineer and Kent County Public Works written permission.
- B. There is no existing sewer service at the site.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including shell.
 - b. Faulty operation of sewage pumps, controls, or accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Shells: Two (2) years from date of Substantial Completion.
 - 3. Warranty Period for Sewage Pumps and Controls: Two (2) years from date of Substantial Completion.
 - 4. Warranty Period for Accessories: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WET-WELL, PACKAGED SEWAGE PUMPING STATION

- A. Wet-Well, Packaged Sewage Pumping Stations with Submersible Grinder Sewage Pumps:
 - 1. 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:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Subject to compliance with requirements, provide the models depicted on the contract drawings as manufactured by Environment One Corporation (E-One) or an Owner approved equal.
 - 4. Description: Wetwell/Drywell Grinder Pump Station, consisting of duplex grinder pumps suitably mounted in a basin constructed of Fiberglass Reinforced Polyester Resin with dimensions and capacities as show on the Contract Drawings, NEMA 6P electrical quick disconnect (EQD), pump removal system, stainless steel discharge assembly/shut-

off valve, anti-siphon valve/check valve, each assembled in the basin, electrical alarm panel and all necessary internal wiring and controls. Component type grinder pump systems that require field assembly will not be acceptable due to the potential problems that can occur during field assembly.

- a. Orientation: Shell underground with dry equipment chamber underground with top flush with grade.
- b. Shell: Factory fabricated from fiberglass reinforced polyester resin.
- c. Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches in diameter.
- d. Cathodic Protection: Exterior magnesium anode(s).
- e. Sewage Pumps: Two submersible grinder-type sewage pumps, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

5. Capacities and Characteristics:

- a. Tank Capacity: Varies, see contract drawings..
- b. Height of Shell Base Section: As shown on the contract drawings.
- c. Pumping Station, Inlet Pipe Size: 6"
- d. Pumping Station, Discharge Pipe Size: 1.25". Transition to discharge line size as depicted on the contract drawings.
- e. Sewage Pumps: Two required.
- f. Each Sewage Pump:
 - 1) Capacity: 13 gpm
 - 2) Total Dynamic Head: 51 feet
 - 3) Speed: 1,725 rpm
 - 4) Motor Size: 1 hp.
 - 5) Electrical Characteristics:
 - a) Volts: 240/120 V.
 - b) Phases: Single
 - c) Hertz: 60.
- g. Pumping Station Electrical Characteristics:
 - 1) Full-Load Amperes: 20 amps (duplex condition) (240V)
 - 2) Maximum Overcurrent Protection: 30 amps (240V)

6. Pump:

- a. The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. Double radial O-ring seals are required at all casting joints to minimize corrosion and create a protective barrier. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. This material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and

detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and required for wastewater service.

7. Grinder:
 - a. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft by means of a threaded connection attaching the grinder impeller to the motor shaft. Attachment by means of pins or keys will not be acceptable. The grinder impeller shall be a one-piece, 4140 cutter wheel of the rotating type with inductively hardened cutter teeth. The cutter teeth shall be inductively hardened to Rockwell 50 – 60c for abrasion resistance. The shredder ring shall be of the stationary type and the material shall be white cast iron. The teeth shall be ground into the material to achieve effective grinding. The shredder ring shall have a staggered tooth pattern with only one edge engaged at a time, maximizing the cutting torque. These materials have been chosen for their capacity to perform in the intended environment as they are materials with wear and corrosive resistant properties.
 - b. This assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. The grinder shall be constructed so as to minimize clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:
 - 1) The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
 - 2) The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to minimize jamming and as such must be adhered to.
 - 3) The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and minimizes blinding of the pump by large objects that block the inlet shroud.
 - 4) The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.
 - c. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of “foreign objects,” such as paper, wood, plastic, glass, wipes, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter stainless steel discharge piping.
8. Electric motor:
 - a. As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F installation, low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds.
 - b. The motor shall be press-fit into the casting for better heat transfer and longer winding life. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor.

- c. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. The wet portion of the motor armature must be 300 Series stainless. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted.
9. Check valve:
 - a. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow.
 - b. Moving parts will be made of a 300 Series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure.
 - c. The valve body shall be an injection molded part made of an engineered thermoplastic resin. The valve shall be rated for continuous operating pressure of 235 psi. Ball-type check valves are unacceptable due to their limited sealing capacity in slurry applications.
10. Anti-siphon valve:
 - a. The pump discharge shall be equipped with a factory-installed, gravity-operated, flapper-type integral anti-siphon valve built into the stainless steel discharge piping. Moving parts will be made of 300 Series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength.
 - b. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure.
 - c. The valve body shall be injection-molded from an engineered thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices due to their tendency to clog from the solids in the slurry being pumped.
 - d. The anti-siphon port diameter shall be no less than 60% of the inside diameter of the pump discharge piping.
11. Core unit:
 - a. The grinder pump station shall have a cartridge type, easily removable core assembly consisting of pump, motor, grinder, all motor controls, check valve, anti-siphon valve, level controls, electrical quick disconnect and wiring.
 - b. The core unit shall seal to the tank deck with a stainless steel latch assembly. The latch assembly must be actuated utilizing a single quick release mechanism requiring no more than a half turn of a wrench. The watertight integrity of each core unit shall be established by a 100 percent factory test at a minimum of 5 PSIG.

2.2 CONTROLS

- A. All necessary motor starting controls shall be located in the cast iron enclosure of the core unit secured by stainless steel fasteners.

- B. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above high level alarm, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps.
- C. The level sensing control housing must be integrally attached to pump assembly so that it may be removed from the station with the pump and in such a way as to minimize the potential for the accumulation of grease and debris accumulation, etc.
- D. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The air column shall be integrally molded from a thermoplastic elastomer suitable for use in wastewater and with excellent impact resistance. The air column shall have only a single connection between the water level being monitored and the pressure switch. Any connections are to be sealed radially with redundant O-rings. The level detection device shall have no moving parts in direct contact with the wastewater and shall be integral to the pump core assembly in a single, readily-exchanged unit.
- E. Depressing the push to run button must operate the pump even with the level sensor housing removed from the pump.
- F. Pump Control and Alarm panel:
 - 1. Each grinder pump station shall include the Sentry Protect Plus, Duplex panel. Unit shall be mounted to a mounting rack constructed of 1-5/8" SQ. Stainless Steel Channel equipment frame mounted to a 16" x 16" x 16"; 4,000 psi concrete pad. Contractor to position pad per Owner direction.
 - 2. Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic polyester to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel.
 - 3. The panel shall contain one 15-amp single pole circuit breaker for the alarm circuit and one 15-amp double pole circuit breaker per core for the power circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.
 - 4. The alarm panel shall include the following features: external audible and visual alarm; push-to-run switch; push-to-silence switch; redundant pump start; and high level alarm capability. The alarm sequence is to be as follows when the pump and alarm breakers are on:
 - a. The panel will go into alarm mode if either pump's alarm switch closes. During the initial alarm mode both pumps will run and the alarm light and buzzer will be delayed for a period of time based on user settings (default is 3-1/2 minutes). If the station is still in high-level alarm after the delay, the light and buzzer will be activated.
 - b. The audible alarm may be silenced by means of the externally mounted, push-to-silence button.
 - c. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "off" setting of the alarm pressure switch.
 - d. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the

bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).

- G. Service Equipment/Main Service Disconnect Breaker:
 - 1. A separate, internal breaker rated and approved for use as “service equipment” and acts as a main service disconnect of the grinder pump station shall be provided.
- H. Serviceability:
 - 1. The grinder pump core, including level sensor assembly, shall have two lifting hooks complete with lift-out harness connected to its top housing to facilitate easy core removal when necessary.
 - 2. The level sensor assembly must be easily removed from the pump assembly for service or replacement. All mechanical and electrical connections must provide easy disconnect capability for core unit removal and installation.
 - 3. Each EQD half must include a water-tight cover to protect the internal electrical pins while the EQD is unplugged. A pump push-to-run feature will be provided for field trouble shooting. The push-to-run feature must operate the pump even if the level sensor assembly has been removed from the pump assembly.
 - 4. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 6/A 6M, W or HP shapes, or ASTM A 36/A 36M, plates or beams.
- B. Grout: ASTM C 1107, Grade B, nonshrink cement grout.
 - 1. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- C. Concrete: Concrete is specified in Section 033000 "Cast-in-Place Concrete."

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.
- B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavation, trenching, and backfilling are addressed in other sections of this specification.

3.3 INSTALLATION

- A. Install packaged sewage pumping station components where indicated, according to specific equipment and piping arrangement indicated.
- B. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.
- C. The CONTRACTOR shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.
- D. The grinder pump stations shall not be set into the excavation until the installation procedures and excavation have been approved by the ENGINEER.
- E. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.
- F. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.
- G. Connect anode conductors to grounding lugs on steel housing.

3.4 CONNECTIONS

- A. Sanitary sewer piping installation requirements are specified in Section 221313 "Facility Sanitary Sewers." Drawings indicate general arrangement of piping.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Ground equipment according to electrical specifications.
- D. Connect wiring according to electrical specifications.

3.5 BACKFILL REQUIREMENTS

- A. Proper backfill is essential to the long-term reliability of any underground structure. Several methods of backfill are available to produce favorable results with different native soil conditions. The most highly recommended method of backfilling is to surround the unit to grade using Class I or Class II backfill material as defined in ASTM 2321. Class 1A and Class 1B are recommended where frost heave is a concern, Class 1B is a better choice when the native soil is sand or if a high, fluctuating water table is expected. Class 1, angular crushed stone offers an added benefit in that it doesn't need to be compacted.

- B. Class II, naturally rounded stone, may require more compactive effort, or tamping, to achieve the proper density. If the native soil condition consists of clean compactible soil, with less than 12 percent fines, free of ice, rocks, roots and organic material, it may be an acceptable backfill. Soil must be compacted in lifts not to exceed one foot to reach a final Proctor Density of between 85 percent and 90 percent.
- C. Backfill of clean native earth, free of rocks, roots, and foreign objects shall be thoroughly compacted in lifts not exceeding 12" to a final Proctor Density of not less than 85 percent. Improper backfilling may result in damaged accessways

3.6 IDENTIFICATION

- A. Install identifying labels permanently attached to equipment.
- B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.
- C. Arrange for installing green[**warning tape or**] detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Section 312000 "Earth Moving."

3.7 PAINTING

- A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.
- B. Paint field-welded areas to match factory coating.

3.8 FIELD QUALITY CONTROL

- A. Kent County Public Works will perform field inspection, during construction, tests and inspections once constructed and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.. Report results in writing.
- C. Tests and Inspections:
 - 1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
 - 2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 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.
 - 5. Complete a drawdown test to confirm pumping capacity and flowrate.

- D. Remove and replace packaged sewage pumping stations that do not pass tests and inspections and retest as specified above.

3.9 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Adjust pump, accessory, and control settings, and safety and alarm devices.

3.10 MANUALS:

- A. Contractor shall supply four copies of Operation and Maintenance Manuals to the Owner and once copy of the same to the Engineer.

END OF SECTION 221343

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PART 1. GENERAL

1.1. GENERAL

- A. For General Mechanical Requirements, see Division 22 Section, Common Work Results for Plumbing & Division 01, General Requirements.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications apply to this Section.
- C. All exposed bolts, screws, etc., shall be vandal proof.
- D. All plumbing materials, equipment and fixtures shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.
- E. Piping and insulation are specified under other sections.
- F. Use "Sani-Sett" setting compound for fixtures.
- G. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code and International Plumbing Code, the Town of Georgetown, Delaware local code, and all other authorities have jurisdiction. Comply with the current lead free laws per the requirements of the state in which the project is being constructed.
- H. Provide stops for all plumbing fixtures and equipment. Stops are to be accessible.
- I. Provide P traps on fixtures for which traps have not been included as part of furnished equipment. Trap size to equal size of fixture tailpiece.
- J. All exposed metal parts of fixtures shall be chromium plated brass. Piping, fittings, valves, traps and accessories including escutcheons for piping shall be chromium plated where exposed in finished areas.
- K. All faucets for residential kitchen sinks, lavatories, commercial kitchen sinks, and drinking fountains shall be listed for drinking-water or commercial applications by the National Sanitation Foundation (NSF) or Underwriters Laboratory (U.L.). All required faucets shall comply with NSF Standard 61 for both lead content and leaching rate. Submit documentation indicating compliance for all required faucets.
- L. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
 - 1. American Gas Association (AGA).
 - 2. National Sanitation Foundation (NSF).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. National Electrical Manufacturers' Association (NEMA).
 - 5. Underwriters Laboratories (UL).

1.2. REFERENCES

- A. ANSI/ASME A112.6.1 - Supports for Off-the-floor Plumbing Fixtures for Public Use
- B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
- D. ANSI/ASMI A112.19.2 - Vitreous China Plumbing Fixtures.
- E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
- G. ANSI/ASME A112.19.5 -Trim for Water-Closet Bowl, Tanks, and Urinals (Dimensional Standards).
- H. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
- I. ANSI/ARI 1010 - Drinking-Fountains and Self- Contained, Mechanically-Refrigerated Drinking-Water Coolers.
- J. ANSI/NFPA 70 - National Electrical Code.
- K. IBC - International Building Code

1.3. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01, Section General Requirements.
- B. Accept fixtures on site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.4. FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.
- B. Confirm that millwork is constructed with adequate provisions for the installation of counter top lavatories and sinks.

1.5. EXTRA MATERIALS

- A. Provide two sets of faucet washers and flush valve service kits to the Owner. Provide correspondence to Engineer that extra materials have been turned over to the Owner.

1.6. GRAB BAR COORDINATION

- A. For handicapped plumbing fixtures coordinate location of flush valves with grab bars prior to installation.

1.7. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. P-1 Floor Mounted, Exposed, Hard-Wired, Infrared Sensor Flush Valve with Manual Override Button

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Kohler Model K-4406 Wellworth
- b. American Standard
- c. Crane
- d. Sloan
- e. Zurn

2. Bowl:

- a. Material: Vitreous china
- b. Type: Siphon Jet
- c. Style: Flushometer Valve
- d. Height: Standard
- e. Rim Contour: Elongated
- f. Water Consumption: Refer to schedule
- g. Spud Size; Location: NPS 1-1/2; Top

3. Flushometer Valve:

- a. Diaphragm Type: Sloan Model Royal #111-1.6 ES-S, Delany, Zurn or approved equal.
- b. Chrome plated brass.
- c. Self-Adaptive Hard-wired, infrared sensor for automatic “no hands” operation.
- d. Courtesy flush override button
- e. Non-hold open integral solenoid operator.
- f. Infrared sensor range adjustment.
- g. Initial set-up range indicator light.
- h. Transformer to convert 120-VAC power to 24-VAC control circuit power.
- i. 1-inch I.P.S. screwdriver back check angle stop.
- j. Spud coupling and flange.
- k. Locking vandal resistant stop cap.
- l. Adjustable tail piece.
- m. High back pressure vacuum breaker flush connection with one piece bottom hex coupling nut.
- n. Sweat solder adapter with cover tube and cast set screw wall flange.
- o. Split Ring Wall Support: Sloan Model J-312-A.

- p. Provide 3-year limited Manufacturer's warranty.]
 - 4. Transformer: One transformer (Sloan Model EL-154) must be provided for each toilet room with five (5) flushometers or less. Additional transformers shall be provided for every five (5) additional flushometers.
 - 5. Seat: Kohler Model K-4670-C, American Standard 5901.100, solid plastic white seat with open front and check hinge.
- B. P-1A Floor Mounted, Exposed, Hard-Wired, Infrared Sensor Flush Valve with Manual Override Button, Handicapped
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Model K-4405 Highline
 - b. American Standard
 - c. Crane
 - d. Sloan
 - e. Zurn
 - 2. Bowl:
 - a. Material: Vitreous china
 - b. Type: Siphon Jet
 - c. Style: Flushometer Valve
 - d. Height: A.D.A. Compliant
 - e. Rim Contour: Elongated
 - f. Water Consumption: Refer to schedule
 - g. Spud Size; Location: NPS 1-1/2; Top
 - 3. Flushometer Valve:
 - a. Diaphragm Type: Sloan Model Royal #111-1.6 ES-S, Delany, Zurn or approved equal.
 - b. Chrome plated brass.
 - c. Self-Adaptive Hard-wired, infrared sensor for automatic "no hands" operation.
 - d. Courtesy flush override button
 - e. Non-hold open integral solenoid operator.
 - f. Infrared sensor range adjustment.
 - g. Initial set-up range indicator light.
 - h. Transformer to convert 120-VAC power to 24-VAC control circuit power.
 - i. 1-inch I.P.S. screwdriver back check angle stop.
 - j. Spud coupling and flange.
 - k. Locking vandal resistant stop cap.
 - l. Adjustable tail piece.
 - m. High back pressure vacuum breaker flush connection with one piece bottom hex coupling nut.
 - n. Sweat solder adapter with cover tube and cast set screw wall flange.
 - o. Split Ring Wall Support: Sloan Model J-312-A.

- p. Provide 3-year limited Manufacturer's warranty.]
- 4. Transformer: One transformer (Sloan Model EL-154) must be provided for each toilet room with five (5) flushometers or less. Additional transformers shall be provided for every five (5) additional flushometers.
- 5. Seat: Kohler Model K-4670-C, American Standard 5901.100, solid plastic white seat with open front and check hinge.

2.2. WALL-HUNG URINALS

A. P-2 Wall Hung, Exposed, Hard-Wired, Infrared Sensor Flush Valve with Manual Override Button, Handicapped

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Model K-4991-ET Bardon
 - b. American Standard
 - c. Sloan
 - d. Zurn
- 2. Fixture:
 - a. Material: Vitreous china
 - b. Type: Washout
 - c. Rim Height: A.D.A. Compliant
 - d. Water Consumption: Refer to schedule
 - e. Spud Size; Location: NPS 3/4; Top
 - f. Outlet Size; Location: NPS 2; Back
- 1. Flushometer Valve:
 - a. Diaphragm Type: Sloan Model Royal Optima #186-0.125 ES-S, Delany, Zurn or approved equal.
 - b. Chrome plated brass.
 - c. Self-Adaptive Hard-wired, infrared sensor for automatic "no hands" operation.
 - d. Courtesy flush override button
 - e. Non-hold open integral solenoid operator.
 - f. Infrared sensor range adjustment.
 - g. Initial set-up range indicator light.
 - h. Transformer to convert 120-VAC power to 24-VAC control circuit power.
 - i. 3/4-inch I.P.S. screwdriver back check angle stop.
 - j. Spud coupling and flange.
 - k. Locking vandal resistant stop cap.
 - l. Adjustable tail piece.
 - m. High back pressure vacuum breaker flush connection with one piece bottom hex coupling nut.
 - n. Sweat solder adapter with cover tube and cast set screw wall flange.
 - o. Split Ring Wall Support: Sloan Model J-312-A.

- p. Provide 3-year limited Manufacturer's warranty.]
- 2. Transformer: One transformer (Sloan Model EL-154) must be provided for each toilet room with five (5) flushometers or less. Additional transformers shall be provided for every five (5) additional flushometers.
- 3. Carrier: Zurn, Josam or Watts cast iron urinal carrier with fittings as required. ANSI/ASME A112.6.1A; cast iron and steel frame with tubular legs, legs for floor and wall attachment, threaded fixtures studs for fixture hanger, bearing studs.

2.3. WALL-MOUNTED LAVATORIES

A. P-3 Wall-Hung, Deck Mounted, Hard-Wired, Infrared Sensor Faucet

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Model K-2032 Greenwich
 - b. American Standard Lucerne
 - c. Crane
 - d. Zurn
- 2. Fixture:
 - a. Material: Vitreous china
 - b. Type: Wall-Hung
 - c. Rim Mounting Height: Standard
 - d. Nominal Size: 20-3/4"L x 18-1/4"W
 - e. Faucet-Hole Punching: Three Holes, 4-inch centers
 - f. Faucet-Hole Location: Top
 - g. Color: White
 - h. Mounting Material: Concealed Arm Carrier
- 3. Faucet:
 - a. Chicago Faucet 116.706.AB.1, Sloan, American Standard
 - b. Deck Mounted
 - c. Sensor and Solenoid above deck within faucet
 - d. Low-Flow, vandal-proof outlet
 - e. Polished Chrome Finish
 - f. 4-inch Spout
 - g. Integral check cartridges
 - h. Unit shall be A.D.A. Compliant
 - i. 12 Volt AC Transformer
 - j. Splash-proof circuit control module
 - k. Sensor range adjustment screw
- 4. Strainer:
 - a. Chicago Faucet Model 327A, American Standard
 - b. 1-1/4-inch tailpiece

- c. Non-removable brass strainer
 - d. Grid strainer waste
 - e. Chrome plated finished.
5. P-Trap:
- a. Cast Brass 1-1/4-inch "P" trap
6. Stops:
- a. Chicago Faucet Model 1005-ABCP valve stops.
 - b. 3/8-inch loose key cap
 - c. Removable tee handle
 - d. Wall flange
 - e. Chrome plated finished.
7. Thermostatic Mixing Valves:
- a. Provide and install below fixture.
 - b. See Part 2 "Thermostatic Mixing Valves".
8. Carrier:
- a. Zurn, Josan, or Watts cast iron and steel carrier.
 - b. ANSI/ASME A112.6.1
 - c. Cast iron and steel frame with tubular legs.
 - d. Lugs for floor and wall attachment.
 - e. Concealed arm supports.
 - f. Bearing plate and studs.
- B. P-3A Wall-Hung, Deck Mounted, Hard-Wired, Infrared Sensor Faucet, Handicapped
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Kohler Model K-2032 Greenwich
 - b. American Standard Lucerne
 - c. Crane
 - d. Zurn
2. Fixture:
- a. Material: Vitreous china
 - b. Type: Wall-Hung
 - c. Rim Mounting Height: A.D.A. Compliant
 - d. Nominal Size: 20-3/4"L x 18-1/4"W
 - e. Faucet-Hole Punching: Three Holes, 4-inch centers
 - f. Faucet-Hole Location: Top
 - g. Color: White
 - h. Mounting Material: Concealed Arm Carrier

3. Faucet:
 - a. Chicago Faucet 116.706.AB.1, Sloan, American Standard
 - b. Deck Mounted
 - c. Sensor and Solenoid above deck within faucet
 - d. Low-Flow, vandal-proof outlet
 - e. Polished Chrome Finish
 - f. 4-inch Spout
 - g. Integral check cartridges
 - h. Unit shall be A.D.A. Compliant
 - i. 12 Volt AC Transformer
 - j. Splash-proof circuit control module
 - k. Sensor range adjustment screw
4. Strainer:
 - a. Chicago Faucet Model 327A, American Standard
 - b. 1-1/4-inch tailpiece
 - c. Non-removable brass strainer
 - d. Grid strainer waste
 - e. Chrome plated finished.
5. P-Trap:
 - a. Cast Brass 1-1/4-inch "P" trap
6. Stops:
 - a. Chicago Faucet Model 1005-ABCP valve stops.
 - b. 3/8-inch loose key cap
 - c. Removable tee handle
 - d. Wall flange
 - e. Chrome plated finished.
7. Thermostatic Mixing Valves:
 - a. Provide and install below fixture.
 - b. See Part 2 "Thermostatic Mixing Valves".
8. Carrier:
 - a. Zurn, Josan, or Watts cast iron and steel carrier.
 - b. ANSI/ASME A112.6.1
 - c. Cast iron and steel frame with tubular legs.
 - d. Lugs for floor and wall attachment.
 - e. Concealed arm supports.
 - f. Bearing plate and studs.
9. Lavatory Protective Enclosure:
 - a. Provide and install Truebro Model # 2018 lav shield lavatory enclosure on

all lavatories with sensor operated faucets. Protective enclosure shall be ADA conforming, 20-inch x 18-inch wheel chair accessible. Unit shall have white finish, be constructed of high impact, stain resistant vinyl, and include seven (7) wall anchors.

2.4. MOP SINKS

A. P-4 Mop Sink

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Stern Williams Model Hilow-HL

2. Fixture:

a. Material: Terrazzo

b. Type: Floor-mounted

c. Nominal Size: 32"x32"x12"

d. Receptor composed of pearl grey marble chips and white Portland unit, ground smooth, grouted, and sealed to resist stains.

e. Stainless steel cap of one piece 20 gauge, 302 stainless steel cast integral on threshold.

f. Provide and install stainless steel BP splash Catcher panels on adjacent walls.

3. Faucet:

a. Chicago Faucet 897-RCF, Speakman, American Standard

b. Rough Chrome Finish

c. Vacuum breaker spout

d. Stop in arms

e. 3/4-inch hose thread outlet.

f. Pail Hook

g. Wall Brace

h. Stern-Williams T-35 hose, bracket and mop hanger.

2.5. WATER COOLERS – FOUNTAINS

A. P-5 Electric Water Cooler, Dual Height, Surface Mounted, Handicapped, Bottle Filling Station

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay Model LZSTL8WS

b. Halsey Taylor

c. Haws

2. Fixture:

- a. Barrier Free
- b. Dual Height with mounting frame
- c. 8 GPH at 90°F ambient
- d. 50°F outlet drinking water with 80°F inlet water
- e. Top shall be stainless steel
- f. Bubbler valve electronically controlled
- g. Bubbler shall be vandal resistant
- h. Activated by touch pads on sides and front for electronically timed period of flow.
- i. Cabinet shall be powder coated on heavy gauge steel, color to be selected by Architect.
- j. Supplied with plug-in, 3-wire grounding type service
- k. Operation on 120 VAC, Single Phase, 60Hz
- l. Lower Spout Outlet shall be mounted 36-inches maximum above floor.
- m. Upper Spout Outlet shall be mounted 42-inches maximum above floor.
- n. Water cooler and installation shall conform to all requirements of American Disabilities Act Guidelines and ANSI A117.1.

3. Bottle Filling Station:

- a. Electronic Sensor for No-Touch activation
- b. Automatic 20 second shut-off timer
- c. 1.1 GPM flow rate with laminar flow
- d. Water Sentry® Plus, 3,000 gallon capacity filter
- e. Certified to NSF/ANSI 61, UL 399 and CAN/CSA 22.2 No. 120.
- f. Provide replacement filter pack (3 filters per pack) and turn over to Owner.

4. Refrigerant shall be R-134a or equivalent environmentally friendly refrigerant.

5. Provide Carrier as manufactured by Elkay or approved equal.

6. Provide cane apron for water cooler (required where water coolers project more than 4 inches into the corridor).

2.6. TECH/MULTI-STATION SINKS

A. P-6 Wash Fountain

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Bradley Model #WF2804
- b. Acorn Engineering Company

2. Wash Fountain:

- a. Description: Semi-Circular, freestanding-design, wash-up fixture.
- b. Arrangement: Wash-up stations facing central spray head.
- c. Receptor Material: Precast terrazzo on base.
- d. Receptor Color: As selected by Architect.
- e. Size: 54-inch (1370-mm) diameter.

- f. Number of Stations: Four
- g. Control: Infra-red actuation with thermostatic valve and check stops or field-installed check valves.
- h. Liquid Soap Dispensers: Manual, for each station.
- i. Mounting: Floor. Standard Height
- j. Supplies: NPS3/4 (DN20) copper tubing with ball, gate, or globe valves from bottom.
- k. Shroud: Stainless steel of size to cover supplies and vent piping.
- l. Drain: Grid with NPS2 (DN50) tailpiece.
- m. Trap Fitting: NPS2 (DN50) trap with waste and vent connections.
- n. Drain Piping: NPS2 (DN50), waste to floor.
- o. Vent Piping: Off line vent, NPS1-1/2 (DN40) to ceiling.
- p. Bowl depth: 9 inch (228mm)

2.7. EMERGENCY FIXTURES

A. P-7 Combination Emergency Eyewash / Shower (Handicapped)

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian GBF1909
 - b. Bradley S19314TT
 - c. Approved Equal
- 2. Fixture:
 - a. Unit and installation shall comply with ANSI Z358.1, ANSI A117.1 latest edition and ADA requirements.
 - b. Shower Head: 10" diameter ABS plastic with 20 GPM flow control.
 - c. Shower Valve: 1" IPS chrome plated brass stay-open ball valve. Furnish with stainless steel actuating arm and 47" stainless steel pull rod.
 - d. Eye/Face Wash Bowl: 11" diameter stainless steel.
 - e. Spray head assembly: Chrome plated brass eyewash spray head assembly.
 - f. Twin soft flow eye wash heads with dust covers, internal flow control and filter to remove impurities from water flow.
 - g. Eye/Face Wash Valve: Provide 1/2-inch brass stay-open eyewash valve operated by plastic push handle.
 - h. Unit to be floor mounted. Provide floor mount flange.
 - i. Supply: 1-1/4" NPT female top or side inlet.
 - j. Waste: 1-1/4" NPT female outlet. Outlet can be positioned at either 9" of 19" above finished floor.
 - k. Provide and install wrap around modesty curtain with each unit.
 - l. Provide and mount universal identification sign.
- 3. Units shall be tested per ANSI Z358.1 prior to turning over to Owner. Contractor shall train Owner in proper usage per Manufacturer's Instructions and ANSI requirements.
- 4. Furnish each unit with all equipment necessary for field testing of emergency fixtures per ANSI Z358.1 requirements.

5. Refer to Part 2 "Products" of this section for Emergency Mixing Valve.

2.8. CLOTHES WASHER - DRYER

A. P-8 Laundry Tray (Floor Mounted)

1. Laundry tray shall be molded stone, floor mounted model FL-1 as manufactured by Fiat Products or approved equal. Molding shall be done in matched metal dies under heat and pressure resulting in a homogeneous unit. Plug strainer shall be furnished with stopper(s). Capacity shall be not less than 20 gallons.
2. The single tub lavatory tray shall be furnished with and supported by white baked enamel steel angle legs that slip into molded retainers and/or sockets for rigid friction fit. Legs shall be supplied with leveling devices. Unit shall have overall outside dimensions of 23-inches x 21 1/2-inches x 12 17/16-inches. Overall unit height from floor shall be 34 3/4-inches.
3. Faucet: Chicago Faucet 895-L5VBCP deck mounted faucet with chrome plated finish, vacuum breaker spout, stop in arms. Faucet shall include 3/4-inch hose thread outlet and hose shall be Stern Williams T-35.
4. P-Trap: Cast Brass, 1 1/2 inch "P" trap.
5. Stops: Chicago Faucet Model 1005ABCP valve stops with 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.

2.9. THERMOSTATIC MIXING VALVES (INDIVIDUAL FIXTURE TYPE)

- A. Furnish and install thermostatic mixing valves at all public lavatories, and below all lavatories and hand sinks that are provided with hot water temperatures above 109 degrees F.
- B. Thermostatic mixing valves shall be Bradley S59-4000A, Watts, Moen, Leonard Ecobix, Acorn, or approved equal for installation under lavatories. Provide in-line check valves, lead free body, escutcheon plates, inlet filters, and insulation as required. Thermostatic mixing valves shall be adjusted to deliver 105 degrees Fahrenheit hot water when supplied with 140 degrees Fahrenheit delivering hot water. Furnish with adjusting cap with locking feature.
- C. The thermostatic mixing valves shall be listed for use at the scheduled flow rate of the equipment served.
- D. The thermostatic mixing valves shall be ASSE standard 1070 listed.

2.10. PLUMBING FIXTURE SUPPORTS

- A. Wall mounted urinal supports, Josam 17810 plate type with cast iron headers, box steel stanchions, block type cast iron feet with bearing plate.
- B. Support for wall mounted urinals, lavatories, sinks, drinking fountains, etc.:
- C. Where fixtures are supported from concrete or cinder block walls, install No.10 USSG

Steel plate on the opposite side of the wall and bolt hangers or supports through plate. Where opposite side of wall is exposed to view, place bolts in core of blocks and fill core with cement.

- D. Where lavatories with wall hangers have been specified and fixtures are supported from metal stud frame partitions, fixture brackets or mounting lugs shall be through bolted to steel channel crosspieces not less than 1-1/2-inch wide anchored to studs. Bolt heads shall be welded to channel web.
- E. Concealed arm type lavatory supports, Josam 17100 with cast iron headers, box steel stanchions, block type cast iron feet and header; and chrome plated cast brass threaded escutcheons for slab type lavatories.
- F. Flush mounted drinking water cooler supports, Josam 17550 plate type, box steel stanchions, block type cast iron feet.
- G. Water closet chair carriers, Josam 12000 Series for horizontal and vertical installations.

2.11. HANDICAPPED LAVATORY/SINK INSULATION

- A. All handicapped lavatories and sinks shall be provided with under counter pipe and trim insulation.
- B. Insulation shall be fully molded "P" trap and angle valve insulated Hand-I-Lav Guard, Truebro, Pro-Extreme Model #101, 102, and 105 to suit.
- C. Insulation to meet ADA #4 19.4, ANSI A117.1, ASTM C1822, Type III and International Plumbing Code.
- D. Self-extinguishing ASTM D635 burn characteristics, thermal conductivity ASTM C177 K-Value ' 1.17.
- E. Insulation thickness to be minimum 2 inch.
- F. Where lav. Guards are provided insulation may be omitted.

2.12. EMERGENCY COMBINATION EYEWASH/SHOWER MIXING VALVES

- A. Furnish and install factory fabricated, hot-and-cold-water-tempering equipment with dual manifold thermostatic mixing valves. Units shall be manufactured by Guardian Equipment, Power's, Speakman, Leonard, or approved equal.
- B. Thermostatic Mixing Valves: Designed to provide 85 degree F (29 degree C) tepid, potable water at emergency combination eyewash/shower stations to maintain temperature at plus or minus 5 degrees Fahrenheit (3 degrees C) throughout required 15 minute test period, and in case of unit failure to continue cold-water flow with union connections, controls, integral strainer, metal piping, adjustable high temperature limit, outlet and inlet thermometers, check stops, and where indicated a corrosion resistant enclosure.
- C. Capacity Range: As scheduled on Contract Drawings.
- D. Furnish each unit with painted, heavy duty mounting bracket from serving valve to panel

on wall. Cabinet shall be fully recessed, stainless steel, and lockable.

- E. Units shall be provided such that inlets can be rotated 360 degrees for top or bottom supply.
- F. Where installed exposed in finish spaces units shall be chrome plated finish.
- G. Comply with ANSI Z 358-1 2009 and shall comply with the lead free laws per the requirements of the state in which the project is being constructed.
- H. Emergency fixture mixing valves shall be ASSE 1071 compliant.

2.13. FIXTURE STOPS/SUPPLIES

- A. For all lavatories/sinks stops and supplies shall be Chicago Faucets No. 1017-CR43829, Angle Stop Fitting with Supply Tube and Loose Key, Chrome plated solid brass construction. 2-1/4" Metal tee handles with tapered square. Slow compression check cartridge that shall open and close 360° for fine adjustment, valves shall close with water pressure, furnish with square tapered stem. 1/2" NPT female thread inlet 3/8" O.D. female compression outlet. Slip wall flange. 3/8" O.D. x 12" bullnose flexible supply riser. ECAST construction with less than 0.25% lead content by weighted average. This product shall be tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S. 152, and NSF/ANSI 372 Low Lead Content.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

- A. Install all equipment in accordance with manufacturer's instructions.
- B. Setting heights of lavatories, drinking fountains, etc., shall be as directed prior to installation and shall be coordinated with Architectural Contract Documents.
- C. Install floor mounted fixtures only after finished floor has been installed.
- D. Provide rubber concussion washers between vitreous china fixtures and supporting brackets.
- E. Protect chromium plated trim from corrosive solutions used to clean tile work.
- F. Provide white, silicone caulking where fixtures come in contact with walls and floors. Sealant shall be mildew resistant type in accordance with ANSI A-136.1.
- G. Install components plumb and level.
- H. Install and secure fixtures in place with wall supports, wall carriers and bolts.
- I. Solidly attach water closets to floor with lug screws. Lead flashing is not intended to hold fixture in place.
- J. Install flush valve handles on the open side of all ADA waterclosets in accordance with ANSI requirements.

- K. Fixtures shall be vitreous china unless otherwise noted. Cast iron fixtures shall have acid resisting enamel finish unless noted otherwise, color shall be white.
- L. Flush valves shall be self-closing, non-hold open type with vacuum breaker and perform satisfactorily when subject to inlet water pressure varying from 15 to 75 psi. Flush valves shall be as specified, Sloan, Delaney, Zurn, Toto, or approved equal.
- M. Provide flexible risers and loose key stops for all lavatories and sinks. Provide 17 ga. chrome plated brass tail piece and trap with cleanout for all lavatories and sinks.
- N. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve a complete operating system.
- O. Field test all combination eyewash/shower units per ANSI Z358.1 latest edition.
- P. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.
- Q. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.
- R. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.
- S. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.
- T. Coordinate with Architectural Drawings before roughing in plumbing.
- U. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.
- V. See site plan for extent of all piping leaving and entering building.
- W. See domestic water riser diagrams for location of valves, shock absorbers, etc.
- X. Make proper HW, CW, re-cir., waste, and vent connections to all fixtures and equipment even though all branch main, elbows and connections are not shown.
- Y. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed between ceiling and attic insulation.
- Z. Unless otherwise noted, horizontal sanitary piping shall be pitched 1 percent.
- AA. Unless otherwise noted, all domestic water piping and fire protection piping shall be installed on heated side of ceiling insulation.
- BB. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

- CC. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.
- DD. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.2. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

- A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.
- B. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.
- C. Secure supplies to supports or substrate.
- D. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve as appropriate is not indicated.
- E. Install water-supply stop valves in accessible locations.
- F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- G. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.3. TESTING

- A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.
- B. After the building has been occupied and the various equipment is in actual use, the Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.4. CLEANING AND STERILIZATION

- A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:
- B. Through a 3/4-inch hose connection in each branch main and building main, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 ppm. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine into system.
- C. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
- D. When chlorinated water has been brought to every faucet and tap with a minimum

concentration of 200 ppm chlorine, retain this water in the system for at least three (3) hours.

- E. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.
- F. At the end of the retention period, no less than 100 ppm of chlorine shall be present at the extreme end of the system.
- G. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 ppm.
- H. Obtain representative water sample from the system for analysis by an independent and recognized bacteriological laboratory.
- I. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the Contractor, certifying successful completion of the sterilization. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.
- J. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
- K. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.5. EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

3.6. PREPARATION

- A. Confirm rough-in location and size of fixtures and openings prior to commencing work.
- B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.7. ADJUSTING

- A. Adjust stops, valves, infrared fixtures for intended water flow rate to fixtures without splashing, noise, or overflow.

3.8. CLEANING

- A. At completion, clean plumbing fixtures and equipment. Polish all chrome plated faucets, accessories, equipment, and piping.

- B. All electric water cooler coils shall be cleaned of all construction dust and debris prior to building occupation by Owner.

3.9. FIXTURE HEIGHTS

- A. Install fixtures to heights above finished floor as required by local Plumbing Code, Americans with Disabilities Act (A.D.A.), Authority Having Jurisdiction, and Architectural Contract Drawings. In the absence of a local code requirements, install fixtures to heights above finished floor as follows.

- B. Water Closet

- a. Standard 15 inches to top of bowl rim.
- b. Handicapped 18 inches to top of seat.

- C. Urinal

- a. Standard 22 inches to top of bowl rim.
- b. Handicapped 17 inches to top of bowl rim.

- D. Lavatory

- a. Standard 31 inches to top of basin rim.
- b. Handicapped 34 inches to top of basin rim.

- E. Drinking Fountain

- a. Standard 36 inches to top of basin rim.
- b. Handicapped 34 inches to top of basin rim.

- F. Water Closet Flush Valves

- a. Standard 11 inches min above bowl rim.
- b. Recessed 10 inches min. above bowl rim.

- G. Combination Emergency Shower/Eye Wash

- a. Handicapped 84 inches to bottom of shower head and 38 inches to eye wash receptor rim.

END OF SECTION

SECTION 224005 - PLUMBING EQUIPMENT

PART 1. GENERAL

1.1. GENERAL

- A. For General Mechanical Requirements, see Division 22 Section, Common Work Results for Plumbing & Division 01, General Requirements.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications apply to this Section.
- C. All exposed bolts, screws, etc., shall be vandal proof.
- D. All plumbing materials and equipment shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.
- E. Piping and insulation are specified under other sections.
- F. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code , International Plumbing Code, City of Georgetown, Delaware Code, the local code, and all other authorities have jurisdiction.
- G. Provide stops for all plumbing equipment. Stops are to be accessible.
- H. Provide pumps with manufacturer's name, model number, and rating/capacity identified.
- I. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
 - 1. American Gas Association (AGA).
 - 2. National Sanitation Foundation (NSF).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 5. National Electrical Manufacturers' Association (NEMA).
 - 6. Underwriters Laboratories (UL).
- J. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.2. REFERENCES

- A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- B. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

- C. ANSI/ASE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- D. ANSI A112.21.1 - Floor Drains.
- E. ANSI A112.26.1 - Water Hammer Arrestors.
- F. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- G. PDI WH-201 Water Hammer Arresters.
- H. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
- I. ASME Section VIII D - Pressure Vessels; Boiler and Pressure Vessel Codes.
- J. ANSI/NFPA 54 - National Fuel Gas Code.
- K. ANSI/NFPA 70 - National Electrical Code.
- L. IBC - International Building Code

1.3. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of General Requirements.
- B. Accept equipment on site in factory packaging. Inspect for damage.
- C. Protect installed equipment from damage by securing areas and by leaving factory packaging in place to protect equipment and prevent use.

1.4. FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

1.5. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. FLOOR DRAINS

- A. Provide Nikaloy strainers on all floor drains unless specified otherwise.
- B. Provide flashing clamps on all drains penetrating waterproofing membrane.
- C. Provide suitable flashing material and clamping collar for drains which are not set in place when slab is poured.
- D. Provide traps for all floor drains connected to the sanitary system.

- | | | |
|-----|--|------------|
| 5. | Finished Areas Floors | |
| 6. | Terrazzo | 56040-13 |
| 7. | Composition Tile | 57000-X-12 |
| 8. | Ceramic Tile | 57000-X |
| 9. | Carpet | 56070-14 |
| 10. | Carpet insert to match adjacent carpet in type, color and grade. | |
| 11. | Finished Areas Walls | |
| 12. | Plaster/Dry Wall | 58640-COT |
| 13. | Tile/CMU | 58600-COT |

2.3. WALL HYDRANTS

- A. Wall Hydrant (Exterior): Josam 71000 Series Hydrasan anti siphon wall hydrant, 3/4-inch non-freeze, key operated wall hydrant with hinged locking cover, polished bronze box and cover and bronze casing and integral vacuum breaker. Seat and disc shall be removable from front of the hydrant. Wall thickness; see architectural drawings. Wall hydrants shall conform to ANSI/ASSE 1019 with wall plate, lock shield and removable key.
- B. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Mifab, Watts, or approved equal.

2.4. SHOCK ABSORBERS

- A. Provide shock absorbers equal to Josam Shokstops at all fast closing valves, at the top of all cold water risers, at each flush valve or battery of flush valves, and where indicated. Sizes and locations shall be in accordance with PDI Standard WH 201.
- B. Shock absorbers shall conform to ANSI A112.26.1, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.
- C. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Sioux Chief, Watts, or approved equal.

2.5. VACUUM BREAKERS

- A. Provide vacuum breakers on water connections to fixtures and equipment where minimum air gaps required by Plumbing Code are not possible and on hose bibbs and other outlets to which hoses can be attached.
- B. Vacuum breakers not subject to back pressure, Watts No. 288A; vacuum breakers subject to back pressure, Watts Series 9D or for hose threads, Watts Series 8A.
- C. Hose connection backflow preventers shall be ASSE 1052, suitable for at least 5 gpm flow and applications with up to 10 foot head back pressure. Include two (2) check valves,

intermediate atmospheric vent, and non-removable, ASME B1.20.7 garden-hose thread on outlet.

- D. Hose connection vacuum breakers shall be ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze finish hose connections may be rough bronze.
- E. Approved manufacturers: Watts, Beeco, B&K Industries, Zurn, Sparco, Conbraco or approved equal.

2.6. VACUUM RELIEF VALVES

- A. Provide vacuum relief valves on cold water supply to water heaters, where indicated on the contract drawings, or where required by the authority having jurisdiction.
- B. Vacuum relief valves shall be Watts Regulator Co. Series 36A or approved equal.

2.7. HOSE BIBBS

- A. Chicago Faucet No. 952 or approved equal hose and faucet. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose threaded spout, polished chrome plated where exposed in finished areas, with hand wheel and removable key, integral vacuum breaker in conformance with ANSI/ASSE 1011.
- B. Hose bibbs in finished areas shall be polished chrome finish.
- C. Approved Manufacturers: Chicago Faucet, American Standard, Crane, T&S Brass, and Watts.

2.8. DOMESTIC WATER RECIRCULATING PUMPS

- A. Provide and install domestic water re-circulating pumps of the size, capacity and electrical characteristics as indicated on the contract drawings. Pumps shall be in-line circulators Model 113B as manufactured by TACO, Bell and Gossett, Thrush, Armstrong, Patterson, or approved equal.
- B. Pumps shall be non-overloading throughout the range of the curves. Pumps shall have center line discharge for positive venting, flanged bodies, and same size suction and discharge.
- C. Motors shall be resilient mounted, split phase motor with built-in overload protector and equipped with sleeve bearings for quiet operation. Impeller shall be one piece dynamically balanced with stainless steel shaft, bronze sleeve bearing, two piece carbon/ceramic seal assembly and one piece spring coupling.
- D. All circulators utilized for domestic water service shall be stainless steel or all bronze construction.

2.9. GAS FIRED DOMESTIC WATER HEATER

- A. Water Heater shall be model BTH as manufactured by A. O. Smith, Lochinvar, State, Bradford White, Bock, or approved equal. Water heater(s) shall be of the seamless glass

lined steel tank construction in which the glass coating is applied to the water side surfaces of the tank after the tank has been assembled and welded. The condensing flue coil shall be coated on the flue gas side with A. O. Smith's proprietary or equal acid resistant glass lining designed for use in condensing heaters.

- B. The heater shall be suitable for sealed combustion direct venting using PVC air intake pipe and PVC exhaust pipe for a total distance of (50') equivalent feet of vent and 50' equivalent feet of intake. The heater shall be factory assembled and tested. The power burner shall be of a design that requires no special calibrations or start up. The heater(s) shall be approved for 0-inch clearances to combustibles.
- C. The control shall be an integrated solid state temperature and ignition control device with integral diagnostics, LED fault display capability and a digital display of temperature settings.
- D. The tanks shall be foam insulated and equipped with a ASME rated temperature pressure relief valve. The water heater shall be UL listed and exceed the minimum efficiency requirements of ASHRAE/IES 90.1b-1992.
- E. The heater shall be listed by SCAQMD Rule 1146.2 Low NOx. Water Heater shall comply with Delaware Pressure Vessel Code and ASME CSD-1.
- F. Provide unit with brass drain valve and install on 4-inch high housekeeping pad as detailed on the contract drawings.
- G. The water heater shall be tested at start-up by a qualified representative of the manufacturer. Provide a check list outlining start-up procedures to Engineer for review. A start-up report as provided by the manufacturer shall be completed and submitted before final acceptance of the domestic hot water heater system. Include copy of start-up report in O&M Manuals.
- H. Conduct flue gas analysis on unit as required by water heater manufacturer.
- I. Where multiple units are indicated furnish manifold kits to balance water flow through each heater.
- J. Furnish units with electronic temperature control with LED readout.
- K. Accessories: Air proving switch, housekeeping pad, low water cut-off, condensate neutralization kit, temperature and pressure relief valve. The temperature and pressure relief valve must be visible and accessible not hidden behind jacket.
- L. Warranty: Total unit warranty of five (5) years.
- M. A properly sized gas pressure regulator to be provided by the manufacturer and installed by the contractor.

2.10. BACKFLOW PREVENTER (REDUCED PRESSURE PRINCIPAL TYPE)

- A. Furnish and install reduced pressure principal backflow preventers at all cold water make-up connections to HVAC water systems, and where indicated on contract drawings.

- B. Backflow preventers shall be of bronze body construction, inlet and discharge OS&Y gate valves, stainless steel check and relief valve seats, stainless steel relief valve shafts and flange bolts. Ball valve test cocks shall be bronze body.
- C. Pressure ratings shall be up to 175 psi and temperature ratings shall be up to 210 degrees F continuous.
- D. Install unit per local code requirements and authorities having jurisdiction. Unless otherwise noted, install backflow preventers between 12 inches and 60 inches above finished floor.
- E. Units shall be approved by ASSE 1013, UPC, UL, and shall be No. 909 with air gap fitting and inlet/outlet gate valves as manufactured by Watts Regulator, Conbraco, Wilkens, or as approved equal. Pipe discharge to nearest floor drain/floor sink. Provide minimum 18-inch clearance for servicing and testing.
- F. Pipe discharge of backflow preventer full size to closest floor drain utilizing type "L" copper.

2.11. BACKFLOW PREVENTER (DOUBLE CHECK VALVE ASSEMBLY TYPE)

- A. Furnish and install double check valve assembly backflow preventers at all cold water make-up connections to lawn irrigation systems and where else indicated on contract documents.
- B. The assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module sets and seat discs shall be replaceable.
- C. Service of all internal components shall be through a single access cover secured with stainless steel bolts. The assembly shall include two resilient seated isolation valves and four top mounted, resilient seated test cocks.
 - 1. Furnish each backflow preventer with the following accessories and options:
 - a. bronze strainer
 - b. quarter turn, full port, resilient seated ball valve shut-off
 - c. union connections
- D. Provide minimum 18-inch clearance for servicing and testing.
- E. The assembly shall meet the requirement of ASSE Std 1015 and AMCA Std C510.
- F. Double check valve backflow preventers shall be Watts No. 007, Conbraco, Wilkens, Ancon, or approved equal.
- G. Furnish test kit for field testing units. Watts Model TK-9A Analog Differential Gauge or approved equal.

2.12. TRAP SEAL PRIMER VALVES (DIRECT CONNECT TO DOMESTIC WATER)

- A. Supply type, Trap-Seal primer Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS ½ (DN15) threaded union, or solder joint.
6. Gravity Drain Outlet connection: NPS ½ (dn 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Distribution Unit: Outlet quantities required.
9. Backflow Preventer: Atmospheric vented drain chamber.

2.13. TRAP PRIMING STATION-AUTOMATIC TRAP PRIMER

- A. Trap priming stations shall be Precision Plumbing Products, Inc., Electronic Trap Priming manifold Model PT. The manifold shall supply a minimum of 2 ounces of potable water per opening at 20 PSIG once in each 24 hour period. The Electronic Trap Priming Manifold must be capable of equally priming from 4 through 30 individual floor drain traps.
- B. The unit shall be factory assembled and prepiped, and shall include a bronze body 3/4-inch female NPT WOG rated ball valve 3/4-inch, Water Hammer Arrestor, copper barrel with brass piston and type "L" copper sweat connection, electronic brass body 3/4-inch solenoid valve, and type "L" copper manifold with brass 2-inch compression fitting and orifice opening for precision water distribution to each floor drain trap. Unit shall be pre-piped with atmospheric vacuum breaker.
- C. Electronic components shall include single point power connection at 120 volt 1 phase 60 hertz, manual over-ride switch, minimum 5 amp breaker, 24 hour geared timer with relay and 5 second dwell function. Separate water hammer arrestor can be provided outside station if integral arrestor is not available.
- D. All components shall be factory assembled, tested and supplied in a 16 gauge steel enclosure suitable for surface or recess mounting, as indicated on contract drawings. In addition, all components must comply with nationally recognized standards. The Precision Plumbing Products Electronic Trap Priming Manifold shall be fully warranted for the life of the plumbing system.

- E. When only a single trap primer is required, as in the case of a restroom with one floor drain in a toilet (or similar) the contractor may submit, in lieu of an electronic multiple station, a single station for review by the Engineer. The fixture serving the trap primer must be within 10' of the trap. Components shall be brass, bronze, and chrome, of the highest quality.
- F. Access door shall be finished with a prime coat and fire rated where installed in a rated wall. Access door latch shall be Allen key type.

2.14. TRAP SEAL PRIMER VALVES

- A. Provide and install one valve per trap, per floor drain on all remote floor drains. When installed on a fixture in a finished area, primer valve shall be concealed behind an access door. In mechanical rooms, mezzanines, penthouses, and all other locations indicated on contract drawings, priming lines shall be connected to automatic trap primer station. Trap seal primer valves shall be as manufactured by E&S, Precision Plumbing Products, Sioux Chief, Mifab, Watts, or approved equal.
- B. Trap seal primer valves shall be ASSE 1018, water supply fed type with the following characteristics:
 - 1. 125 psig minimum working pressure.
 - 2. Bronze body with atmospheric - vented drain chamber.
 - 3. Inlet and outlet connections: ½ inch NPS threaded or solder joint.
 - 4. Gravity drain outlet connection: ½ inch NPS threaded or solder joint.
 - 5. Finish: chrome plated

2.15. DOMESTIC WATER EXPANSION TANKS

- A. Provide and install domestic water expansion tanks of size, capacity and as indicated on contract drawings. Domestic water expansion tanks shall be Therm-X-TROL as manufactured by AMTROL Inc., Flexcon, Wessels, Taco, Armstrong, or approved equal. Mount tank as detailed on the drawings.
- B. Domestic water expansion tanks shall be specifically designed for use in potable water systems. Tanks shall be pre-charged to require pressure at the factory. The maximum working pressure shall be 150 psig. The maximum operating temperature shall be 200 degrees F. Expansion tanks shall contain removable FDA approved butyl bladder.
- C. Before installation, Contractor shall adjust the tank air pre-charge pressures to equal city water pressure.
- D. The tank must be constructed in accordance with Section VIII of the A.S.M.E. boiler and pressure vessel code and stamped 150 psig working pressure.
- E. Accessories: Pressure gauge and air charging fitting, tank drain, pre-charge as indicated on contract drawings and factory installed clip angles.

2.16. INTERIOR RECESSED WALL HYDRANTS

- A. Provide and install recessed wall hydrants where indicated on the contract drawings. Recessed wall hydrants shall be Zurn Model Z 1330, Josam, Ancon, Mifab, Watts or approved equal.
- B. Units shall be encased Ecotrol "anti-siphon" wall hydrant for interior wall installation. Unit shall be suitable for hot or cold water as indicated on Contract Drawings.
- C. Each unit shall be complete with integral backflow preventer, all bronze interior parts, non-turning operating coupling with hemispherical neoprene plunger and 3/4-inch solder inlet.
- D. Furnish each unit mounted in a stainless steel box and hinged cover with operating key lock and "water" stamped on cover.
- E. Furnish each unit with the following accessories:
 - 1. 3/4 inch – 90 degrees inlet elbow with union nut
 - 2. Cylinder lock
 - 3. Key operator

2.17. COMPRESSED AIR SYSTEMS

- A. Furnish and install all components, piping, fittings, gauges, relief valves, flexible connectors valves, drains, filters, air dryer, regulators, necessary to form a complete and operating a shop compressed air systems to the extent indicated on the contract drawings utilizing new air compressor(s) and tank. This contractor is responsible for all equipment, rough-in and final connections as detailed on the contract drawings/specifications.
- B. Contractor shall mount air compressor/receiver on vibration isolation material and bolt to concrete housekeeping pad. Flexible piping shall be provided between receiver and piping systems. Contractor shall provide and install piping from each compressors tank drain and refrigerated air dryer drain to adjacent floor drain. Compressed air piping shall be pitched to drain at suitable locations in the system. Refer to Division 22 Section, Plumbing Piping, Fittings, & Valves for pipe material and installation requirements.
- C. Air compressors: Furnish and install lubricated, reciprocating air compressors of the size, capacity, arrangement, and electrical characteristics as detailed on the contract drawings. Air compressors shall be Champion, Gardner Denver, Quincy, Ingersol Rand, Kaeser or approved equal. Air compressors shall include the following performance features:
 - 1. Provide factory assembled and tested, duplex, packaged and assembled, 100 percent continuous duty rated, belt driven, splash or pressure lubricated, two stage reciprocating, piston type, centrifugal air compressors as indicated, of capacities and electrical characteristics indicated on contract drawings.
 - 2. Compressors shall be cast iron construction with multi-finned cylinders for maximum cooling, gasket free integral cylinder/head, ductile iron crankshaft, aluminum or cast iron pistons and connecting rods, Swedish steel disc type valves,

balanced flywheel with fan cooling blades, large diameter, finned inter-coolers, positive acting centrifugal un-loader, tapered roller bearings, inter-stage pressure relief valves, heavy duty 5 micron inlet filter/mufflers, oil sight gauge and drain, low oil shutdown switch, enclosed OSHA belt guards, EPACT '92 energy efficient open drip proof motor, and U.L. listing.

3. Air compressors shall be tank mounted. Tank mounted compressors shall include ASME code 200 PSIG horizontal air receiver. Air receiver shall include 0-300 PSIG liquid filled pressure gauge with snubber and needle valve, bucket high drain valve, ASME code bronze pressure relief valve, hand operated ball valve, factory set pressure switch. The receiver shall have base ring or support legs for mounting to concrete housekeeping pad. Vibration isolators shall be provided for the receiver. Receiver shall include automatic timed solenoid drain as specified. Tank shall be fully primed and finished in manufacturer's standard finish.
 4. Air compressor shall be arranged for automatic start-stop control. Each compressors shall be supplied with pressure switch to control each compressor. Each pressure switch shall have adjustable differential control.
 5. Each air compressors shall be supplied with an air cooled after-cooler. After cooler shall bring compressed air discharge temperature to within 20 degrees F of ambient air temperature. Unit shall be finned radiator type and packaged directly on compressor. A packaged moisture separator and trap shall be provided to remove all condensate removed from compressed air.
 6. Compressed air systems shall be supplied with unit mounted and wired control panel as follows:
 - a. Control panel shall be NEMA 1 general purpose indoor enclosure
 - b. Combination Magnetic motor starters with individual thru-the-door disconnects, motor overloads and external reset buttons
 - c. Hand-Off-Automatic Selector Switches
 - d. Control voltage transformers - Primary & Secondary
 - e. Low oil monitor with shutdown
 - f. Power on light
 - g. Compressor run light
 - h. Automatic alternator timed rotation alternator
 7. Compressor package shall have one year parts warranty from date of start-up, or (18) months from date of shipment. Compressed air end shall have (60) month warranty from date of start-up or (66) months from date of shipment. This shall include parts and labor on compressor air end.
- D. Refrigerated Air Dryer: Furnish and install a cycling refrigerator air cooled dryer with the capacity and electrical characteristics as scheduled on the contract drawings. Refrigerated air dryer shall be Heatsink Model HSE as manufactured by Zeks, Arrow Pneumatics, Ingersoll-Rand or approved equal. Furnish refrigerated air dryer with the following performance features:
1. Unit shall be heat sink type and consist of a mechanical refrigeration system, equipped with automatic temperature control that will cycle the refrigerated system

to match variable loads from 0 percent to 100 percent capacity.

2. Specially formulated heat sink material shall surround a smooth bore copper tube on tube evaporative section. The heat sink material shall be cooled by the refrigeration system which in turn shall cool the tubes to cool the dry compressed air. Refrigeration compressor horsepower shall be as specified on contract documents and shall be hermetic type equipped with automatic start-stop capacity control.
 3. Moisture separator shall be low velocity centrifugal type.
 4. Unit shall be controlled by micro-processor controller including exchanger temperature, % savings digital display, dew point temperature, adjustable dew point setting, automatic solenoid drain with drain open/closed adjustment, drain test switch, anti-rapid cycle timer, high temperature alarm light with relay for remote, low temperature alarm light with relay for remote, Fahrenheit and Centigrade temperature display, refrigerant suction pressure gauge, installed drain trap, on/off switch with power on light.
 5. Unit shall be U.L. listed and furnished with packaged automatic solenoid drain. Pipe condensate trap to floor drain and install dryer on a 4-inch high housekeeping pad.
- E. Compressed Air filters: Furnish and install particulate and coalescing filters of capacity and quantity as indicated on the contract drawings. Filters shall be as follows:
1. 3-Micron Particulate filters - Units shall have corrosion resistant cast aluminum ally head and aluminum alloy bowl. Bowl assembly shall have threaded connections with "O"ring seal for easy access for cartridge replacement. Unit shall have durable enamel finish. Filter shall have pressure drop indicator to indicate filter replacement and installed internal automatic drain. Unit shall have 3-micron absolute removal. Unit shall be Zeks "PT" series, Arrow, Ingersoll-Rand, Kaeser or approved equal.
 2. 0.3 Micron Coalescing Filter - Unit shall have corrosion resistant cast aluminum alloy head and aluminum alloy bowl. Bowl assembly shall have threaded connections with "O" ring seal for easy access for cartridge replacement. Unit shall have durable enamel finish. Filter shall have pressure drop indicator to indicate filter replacement and installed internal automatic drain. Unit shall have 0.3-micron absolute removal. Unit shall be Zeks "LT" series, Arrow, Ingersoll-Rand, Kaeser or approved equal.
 3. All filters and housings shall be constructed to withstand 250 psig maximum working pressure.
- F. Compressed Air Pressure Regulators: Provide and install pressure regulator where indicated with built-in safety relief valve. Outlet pressure is to be set as specified and to remain constant regardless of inlet air pressure and changes in downstream flow requirements. Unit to be provided with high pressure gauge on outlet and high pressure gauge on inlet. Provide three (3) valve bypass around pressure reducing station as detailed on contract drawings. Pressure regulator shall be constructed of aluminum alloy or Zinc,

diaphragm operated, direct acting, spring loaded design with manual adjustment knob and rated 300 psig maximum. Unit shall be relieving type with balanced valve design. Main pressure regulator shall be Arrow, Hankison, Kaeser, Wilkerson or approved equal.

- G. Compressed Air Combination Pressure Regulator/Filter/Lubricator: Furnish and install combination pressure regulator/filters/ lubricators of the capacity and quantity as indicated on the contract drawings. Units shall be provided with built-in safety relief valve. Outlet pressure to be maintained at scheduled value regardless of inlet air pressure and changes in downstream flow requirements. Unit to be provided with high pressure gauge on outlet and inlet. Valve body shall be constructed of zinc. Assembly shall be diaphragm operated, direct acting, spring loaded design with balanced valve design. Filter shall be constructed of sintered polypropylene. Lubricator shall be equipped with drip chamber and sight dome for observing oil drop entering airstream, with a oil-feed adjustment screw and quick-release collar for easy bowl removal. Lubricant shall be non-detergent, petroleum base oil no heavier than SAE 10. The maximum oil droplet flow rate shall be one drop of oil for every SCFM air delivered at 80 psig. Combination units shall be Model C as manufactured by Wilkerson, Arrow, Hankison, Kaeser, Mastercraft, or approved equal.
- H. Each compressed air system shall be equipped with a main safety relief valve. Safety relief valves shall be ASME BPVC Section VIII DI and ASME BPVC Section IX Code stamped safety valve, for unfired pressure vessels, bronze, with threaded or flanged connectors; factory set and sealed.
- I. Provide and install pressure gauges at all locations shown on contract drawings. Pressure gauges shall be ANSI/ASME B40.1 rated, Accuracy Grade A, for air, with steel or brass case, and nonshatterable safety glass, and a pressure blowout back to prevent glass from flying out in case of an explosion. Gauges shall have a 3 1/2-inch minimum diameter dial and a dial range of approximately twice working pressure.
- J. Furnish and install as indicated on drawings, timed automatic condensate drain. Unit shall be 200 PSIG working pressure. Unit shall consist of condensate reservoir, timer operated solenoid drain. Unit shall have fully adjustable drain cycle time, fully adjustable valve open duration, power on light, valve open light, NEMA 4 UL/CSA approved housing, solid state timer, and eight foot, three prong power cord. Units shall be as manufactured by Arrow Pneumatics, Hankison, Zeks, Sparten or approved equal.
- K. Furnish and install adjustable pressure regulators at each compressed air drop, and equipment as detailed on the contract drawings. Pressure regulators shall include balanced valve design, spring loaded diaphragm, adjustment knob, built-in pressure gauge, drain plug and zinc body. Units shall be selected and constructed to withstand a maximum working pressure of 250 psig. Units shall be as manufactured by Arrow Pneumatic, Hankison, Zeks, Sparten, Vanguard or approved equal.
- L. Provide and install quick disconnect couplings at all drops and wherever indicated on contract drawing. Quick disconnect coupling shall be all brass and suitable for a working pressure of not less than 200 psig. Female side of coupling shall (fixed end) have male thread connection with automatic shutoff. Provide male side of coupling with hose stem and ball check to bleed pressure from hose and prevent hose whipping. Provide two (2) quick disconnects at compressed air drops where indicated on contract drawings. Quick connect/disconnect hose couplings shall be as manufactured by Aero-Quip, Champion, Hansen, Schrader or approved equal.

- M. Where indicated on contract drawings, contractor shall provide rough-in and final connection to equipment provided by owner or under another Division of these specifications.
- N. Factory start-up shall be provided by manufacturer's representative. Start-up shall include a minimum (4) hours and should include complete operational check of compressed air system, pressure switch adjustments, motor amp draw, and correct operation of all system components. Manufacturer's representative shall also instruct owner's personnel on operation and maintenance of the compressed air system components.

2.18. HIGH/LOW MIXING VALVES WITH CABINET

- A. Furnish and install high/low thermostatic controller valves of the size, capacity and arrangement as scheduled on the contract drawings. Units shall be pre-piped and installed within a surface mounted cabinet.
- B. Each unit shall consist of two (2) thermostatic controllers with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows element mounted out of water, inlet manifold piping, pressure reducing valve (PRV), two (2) pressure gauges, two (2) ball valves, bi-metal dial thermometer (3-inch face, range 201 – 240 degrees F), wall bracket, connecting piping and fittings to cabinet limit.
- C. All equipment and piping shall be finished in rough bronze and/or copper. Bottom supplies and top outlet. Field insulate all piping within the cabinet as specified in Division 22 Section, Plumbing Insulation.
- D. Cabinet shall be surface mounted with 16 gauges body, white baked enamel finish, 12 gauge left hinged door with cylinder lock and key.
- E. Complete unit shall be factory assembled and tested. Field insulate all piping within enclosure.
- F. High/low mixing valves shall be Symmons, Lawler, Powers, Acorn, or approved equal.
- G. High/low mixing valves must be piped per the manufacturer's recommendations.
- H. High/low mixing valves shall be ASSE 1017 rated.

2.19. GAS ZONE VALVE BOX

- A. The Zone Valve Box shall be constructed of 18 gauge steel with a white, baked enamel finish, and provided with two steel brackets to anchor the box to the wall. Anchor brackets shall be so designed to permit boxes to ganged together in a vertical stack. Size and select valve boxes to accommodate quantity of pipes and valves as indicated on the Contract Drawings.
- B. Manual valves, where indicated shall be full flow, double seal, ball type with: bronze body, buna-N seals and O-ring packing, chrome plated brass ball and designed for working pressures up to 300 P.S.I.G. Only 3 turn of the handle shall be required to operate the valve from full "ON" to "OFF" position. In the "OFF" position, the valve handle shall protrude

from the box to prevent the door from being shut. The valve shall be securely attached to the back of the box and provided with type L or K copper tube extensions for making connection to concealed piping outside of the box. Electric solenoid valves shall be as herein specified.

- C. The zone valve box assembly shall have a sliding, transparent door with a pull handle and release button which retains the door in the "OPEN" and "CLOSED" positions. In an emergency, the door shall "SNAP-OUT" without exposing sharp edges. The release button shall incorporate a locking device which prevents the valve from being operated by unauthorized persons. A molded plastic cover shall trim the box to the rough wall opening. The top and bottom of the cover shall have interlocking edges for vertical, gang mounting, installations. The front of the cover shall be trimmed with brushed finish stainless steel.
- D. Zone valve boxes shall be selected to accommodate the type, size and quantity of valves as indicated on the contract drawings. Zone valve box shall be Puritan-Bennet, Medaes, Potter Rhoemer, or approved equal.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

- A. Install all equipment in accordance with manufacturer's instructions.
- B. Install components plumb and level.
- C. Cleanouts in vertical pipes shall be installed in tees near floor. Cleanouts in horizontal pipes shall be installed with wyes on long sweep quarter beds. Cleanouts punching water proofing membranes shall have flashing clamps. Cleanout access covers in dry wall or gypsum board shall be painted to match walls.
- D. Unless otherwise noted, drains are to be installed at the low point of floors. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- E. Install floor drains in low points so the top of grates are at or below the finished floor level.
- F. Drains not functioning properly shall be removed and re-installed properly at the expense of the contractor.
- G. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.
- H. Extend cleanouts to finish floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- I. Encase exterior cleanouts in concrete flush with grade.
- J. Install water heaters in accordance with manufacturer's instructions and to AGA, NSF, ANSI/NFPA 54, UL requirements and Delaware Boiler and Pressure Vessel Safety Act and Regulations. For gas fired water heaters, conduct a combustion flue gas analysis.

- Submit flue gas analysis report to Engineer for review. Record and submit design and actual draft at appliance vent connection.
- K. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve a complete operating system.
 - L. Provide painted steel pipe support for tanks independent of building structural framing members.
 - M. Clean and flush domestic water heater storage tanks after installation. Seal until pipe connections are made.
 - N. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
 - O. All plumbing, vents in exterior walls shall be offset a minimum of 3'-0" in ceiling at roof before penetration.
 - P. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.
 - Q. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.
 - R. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.
 - S. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.
 - T. Coordinate with Architectural Drawings before roughing in plumbing.
 - U. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.
 - V. See site plan for extent of all piping leaving and entering building.
 - W. See domestic water riser diagrams for location of valves, shock absorbers, etc.
 - X. Make proper HW, CW, re-circ., waste, and vent connections to all equipment even though all branch main, elbows and connections are not shown.
 - Y. Cleanouts shall be provided near base of each vertical waste or solid stack. Provide 18" minimum clearance for access.
 - Z. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed between ceiling and roof insulation.

- AA. Unless otherwise noted, horizontal sanitary piping pitches shall be 1 percent.
- BB. Unless otherwise noted, all domestic water piping and fire protection piping shall be installed on heated side of ceiling insulation.
- CC. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.
- DD. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.
- EE. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.2. DOMESTIC WATER HEATER INSTALLATION REQUIREMENTS

- A. Install units on concrete bases, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Anchor units to substrate.
- C. Install combustion air and flue vents as detailed on contract drawings. Terminate and install combustion air and flue vent piping per manufacturer's requirements.
- D. Install condensate hose below exhaust elbow per manufacturer's requirements. Extend condensate hose continuous downward pitch and discharge into condensate neutralizer. Install lime chips in condensate neutralizer.
- E. Install temperature and pressure relief valves in top portion of storage tank shells of units with storage. Use relief valves with sensing elements that extend into shells. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain. Install union on relief valve discharge piping. Install automatic air vent at top of hot water supply piping with union ball valve.
- F. Install pressure relief valves in water piping for units without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.
- G. Install vacuum relief valves in cold water inlet piping.
- H. Install unit drain piping as indirect waste to spill into open drains or over floor drains. Install hose end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section, Plumbing Piping, Fittings and Valves for drain valves.
- I. Install thermometers on unit inlet and outlet piping. Refer to Division 22 Section, Plumbing Piping, Fitting and Valves for thermometers. Install pressure gages on unit piping.
- J. Fill unit with water. Install domestic water expansion tank and charge with air. Install

piping adjacent to units to allow service and maintenance.

- K. Connect hot and cold water piping with shutoff valves and unions. Connect hot water circulating piping with shutoff valve, check valve, and union.
- L. Make connections with dielectric fittings where piping is made of dissimilar metal.
- M. Electrical Connections: Power wiring is specified in Division 26 Sections. Arrange wiring to allow unit servicing.
- N. Ground equipment
 - 1. Tighten electrical connectors and terminals according to manufacturers published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Engage a factory authorized service representative to perform startup service.
- O. In addition to manufacturer's written installation and startup checks, perform the following:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
 - 2. Verify that piping system tests are complete.
 - 3. Check for piping connection leaks.
 - 4. Check for clear relief valve inlets, outlets, and drain piping. Check operation of circulators.
 - 5. Test operation of safety controls, relief valves, and devices. Energize electric circuits.
 - 6. Adjust operating controls.
 - 7. Adjust hot water outlet temperature settings. Do not set above 140 deg F 60 deg C unless piping system application requires higher temperature.

3.3. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

- A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.
- B. Install backflow preventers of type, size, and capacity indicated, at each water supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air gap fitting on units with atmospheric vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer. Label all piping downstream of backflow preventers as "non-potable" water.
- C. Field test all backflow preventers and submit test reports to Engineer. Furnish test kits as required for field testing.

- D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve, and where indicated.
- F. Install hose bibbs with integral or field installed vacuum breaker.
- G. Install wall hydrants with integral or field installed vacuum breaker.
- H. All hose bibbs shall be mounted 18" above finished floor, unless otherwise specified.
- I. All wall hydrants shall be mounted 24" above finished grade unless otherwise specified.
- J. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow. Install trap priming stations plumb and level with adequate access for servicing and maintenance.
- K. For floor drains located in toilet rooms and similar spaces where flush valves are utilized. Contractor may utilize trap primer line from flush valve tail piece.
- L. Fasten recessed, wall mounting plumbing specialties to reinforcement built into walls.
- M. Secure supplies to supports or substrate.
- N. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve as appropriate is not indicated.
- O. Install water supply stop valves in accessible locations.
- P. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons if required to conceal protruding pipe fittings.
- Q. Include wood blocking reinforcement for recessed and wall mounting plumbing specialties.
- R. Install ball valves at all shock absorbers to allow removal for service/replacement.

3.4. FITTINGS FOR FIXTURES SUPPLIED BY OTHERS

- A. Fixtures such as built in sink in counters may be provided under other divisions of the specifications and are complete with strainer and tailpiece. Fittings, accessories and connection of these fixtures to the plumbing system are provided under this section.
- B. Rough-in and final connection includes but is not limited to all domestic water, waste, and vent, gas and compressed air systems. Furnish stops, strainers, vacuum breakers, and under counter insulation where not furnished under another Division of these specifications.

3.5. TESTING

- A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.
- B. After the building has been occupied and the various equipment is in actual use, the Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.6. CLEANING AND STERILIZATION

- A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:
 - 1. Through a 3/4-inch hose connection in each branch main and building main, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 ppm. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine into system.
 - 2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
 - 3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 ppm chlorine, retain this water in the system for at least three (3) hours.
 - 4. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.
 - 5. At the end of the retention period, no less than 100 ppm of chlorine shall be present at the extreme end of the system.
 - 6. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 ppm.
 - 7. Obtain representative water sample from the system for analysis by an independent and recognized bacteriological laboratory.
 - 8. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the Contractor, certifying successful completion of the sterilization. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.
 - 9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
 - 10. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.7. EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

3.8. PREPARATION

- A. Confirm rough-in location and size of fixtures and openings prior to commencing work.
- B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.9. INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.10. CLEANING

- A. At completion, clean plumbing equipment.

3.11. WATER HEATER INSTALLATION REQUIREMENTS

- A. Install water heaters level and plumb, according to layout drawings, original design, manufacturer's requirements, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section, Plumbing Pipes, Valves and Fittings for thermometers.
- C. Fill water heaters with water.
- D. Size and install combustion air and flue pipes per manufacturer's requirements
- E. Piping installation requirements are specified in other Division 22 Section Plumbing Pipes, Valves and Fittings. Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- G. Ground equipment according to Division 26 Section, Grounding and Bonding.
- H. Connect wiring according to Division 26 Section, Conductors and Cables.
- I. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- J. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- K. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.
- L. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instantaneous electric water heaters. Refer to Division 01 Section, Closeout Procedures and Demonstration and Training.
- M. Provide flue gas analysis for gas fired heaters. Verify minimum and maximum water flow rates.
- N. Test and record incoming and outgoing temperatures of all water heaters.
- O. Discharge condensate for water heater through condensate neutralizer per manufacturer's requirements. Install lime chips in condensate neutralizer. Terminate condensate over floor drain with suitable air gap.

END OF SECTION

SECTION 230500 COMMON WORK RESULTS FOR HVAC

PART 1. GENERAL

1.1. SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, ductwork, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Submittals specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 23 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.2. PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with the Division 01, General Requirements of the specification.

1.3. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors' failure to do so.
- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct

locations.

1.4. CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 23 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:
 - 1. A list of not less than five comparable projects which the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership in trade or professional organizations where required.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.5. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.6. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame

spread of 25 and smoke developed of 50.

1.7. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.
- B. AABC Associated Air Balance Council
- C. ABMA - American Boiler Manufacturers Association
- D. ACCA - Air Conditioning Contractors of America
- E. ASA - Acoustical Society of America
- F. ADC Air Diffusion Council
- G. AGA American Gas Association
- H. AMCA Air Movement and Control Association
- I. ANSI - American National Standards Institute
- J. ARI - Air Conditioning and Refrigeration Institute
- K. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
- L. ASME - American Society of Mechanical Engineers
- M. ASPE - American Society of Plumbing Engineers
- N. ASTM - American Society for Testing and Materials
- O. ASME CSD-1 - American Society of Mechanical Engineers Controls and Safety Devices for Automatically Fired Boilers
- P. CS - Commercial Standard
- Q. CSD Control and Safety Devices
- R. DNREC - Delaware Department of Natural Resources
- S. FM - Factory Mutual
- T. IBC - International Building Code
- U. IBR - Institute of Boiler and Radiator Manufacturers
- V. IEEE - Institute of Electrical and Electronics Engineers
- W. MSSP - Manufacturers Standards Society of the Valve and Fittings

Industry

- X. NEC - National Electrical Code
- Y. NEMA - National Electrical Manufacturers Association
- Z. NFPA - National Fire Protection Association
- AA. NSF - National Sanitation Foundation
- BB. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
- CC. UL - Underwriters' Laboratories
- DD. State of Delaware Fire Protection Regulations.
- EE. All mechanical equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled Codes and Standards.

1.8. SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.
- B. After acceptance of Material and Equipment List, submit six (6) copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.
- C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.
- D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.
- E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

- F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- I. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.9. SHOP DRAWINGS

- A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.
- D. Items and Systems
 - 1. Access Doors/Panels including layouts and locations
 - 2. Airflow Monitoring Stations
 - 3. Air Cooled Condensing Unit
 - 4. Air Handling Units
 - 5. Air Distribution Systems
 - 6. Air Separators
 - 7. Automatic Temperature Control Systems and Equipment
 - 8. Boiler Accessories, Trim, Flow Switches
 - 9. Boiler Burners
 - 10. Boilers and Accessories

11. Branch Selector Boxes/Heat Recovery Boxes
12. Breaching and Stacks
13. Carbon Dioxide Sensors
14. Carbon Monoxide Makeup Air/Exhaust Units
15. Carbon Monoxide System Hose Reels
16. Carbon Monoxide Sensors
17. Carbon Monoxide Detectors
18. Central Control and Monitoring Systems (CCMS) and Equipment
19. Chemical Feed Systems
20. Condensate Pumps
21. Condensing Units
22. Coordinated Drawings
23. Direct Buried Piping
24. Drip Pans
25. Duct Materials
26. Duct Mounted Hot Water Heating Coils
27. Electric Radiant Heat Panels
28. Energy Recovery Ventilators
29. Equipment Rails
30. Expansion Tanks and Accessories
31. Exterior Equipment Supports
32. Fans
33. Filters
34. Fire Stopping - Methods and Materials
35. Fire Dampers
36. Flow Measuring Stations

37. Flowmeter and Primary Elements (Flow Fittings)
38. Grilles, Registers, Diffusers
39. Heating & Ventilating Units
40. Horizontal Hot Water Unit Heaters
41. Identification Systems
42. In-Line Circulators
43. Louvers
44. Material and Equipment Lists
45. Operations and Maintenance Manuals
46. Pipe Enclosures
47. Pipe Guides and Anchors
48. Pipe Materials Including Itemized Schedules
49. Preliminary Testing and Balancing Reports
50. Pressure Relief Valves
51. Pressure Regulating Valves
52. Pumps
53. Radiant Heat Panels
54. Refnets
55. Screen shots of ATC System Graphics
56. Split System Air Conditioning Units Ductless
57. Static Pressure Gauges
58. Strainers
59. Test Certificates
60. Thermal Insulation Materials Include Table Summaries
61. Thermometers and Gauges
62. Unit Heaters

63. Variable Frequency Drive Motor Bearing Protective Rings
 64. Variable Refrigerant Volume Equipment
 65. Variable Speed Drives
 66. Vibration Isolation Materials
 67. Water Heater Flue/Combustion Air Piping
 68. Water Treatment Services
 69. Weatherproof Assembly Components
 70. Wiring Diagrams, Flow Diagrams and Operating Instructions
- E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked Reviewed or Comments Noted. After the proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect.
- F. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.10. SUPERVISION AND COORDINATION

- A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.
- B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, ductwork, equipment, and other work performed under Division 23.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- D. Coordinate electrical work required under Division 23 with that under Division 26. Coordinate all work under Division 23 with work under all other Divisions.
- E. Supply services of an experienced (10 year minimum) and competent Project Manager to be in constant charge of work at site.
- F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.
- G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the

intent of the contract documents.

- H. Coordinate installation of large equipment requiring positioning before closing in building. Where required arrange for manufacturer to ship equipment in modules.

1.11. CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 23. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.
- B. Do not cut structural members without approval from the Architect or Engineer.

1.12. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.
- B. Where pipes penetrate roofs, flash pipe with Stoneman Stormtite, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.
- C. Furnish and install pitch pockets or weather tight curb assemblies where required.
- D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.13. CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 23. Perform work in accordance with requirements of other applicable Divisions of these specifications.
- B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.14. EXCAVATION AND BACKFILLING

- A. General
 - 1. Perform all necessary excavation, or installation of work under Division 23, in

whatever materials or conditions encountered, using suitable methods and equipment.

2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSH Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.15. DRIVE GUARDS

- A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.
- B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.16. VIBRATION ISOLATION

- A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, piping or ductwork to building structure. See Division 23 Section, "Vibration Control for HVAC, Plumbing and Fire Protection Equipment".

1.17. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.18. FASTENERS/CAPS

- A. For all exterior grade mounted equipment containing refrigerant install lockable caps on service valves to prevent tampering. Lockable caps shall be Model NPR as manufactured by Rector Seal or approved equal. Provide Model NPR Novent screwdriver tool with swiveling tip. Caps shall be suitable and specific for the refrigerant type utilized.

1.19. DEFINITIONS

- A. Approve - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. Furnish and install or provide means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- C. Contractor means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- D. Piping includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. Ductwork includes duct material, fittings, hangers, insulation, sealant, identification and other accessories
- F. Concealed means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.
- G. Exposed means not installed underground or concealed as defined above.
- H. Invert Elevation means the elevation of the inside bottom of pipe.
- I. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- J. Review - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- K. Building Line: Exterior wall of building.

1.20. MINIMUM EFFICIENCY REQUIREMENTS

- A. All heating, ventilating, and air conditioning equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- B. All piping, ductwork, and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.

- C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- D. All mechanical devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.21. SYSTEM INTEGRATION

- A. For all HVAC equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system, provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.
- B. HVAC equipment submittals requiring system integration as defined above must identify all required system integration points.
- C. HVAC equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.
- D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the HVAC equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to HVAC equipment being delivered to the project.
- E. Once the HVAC equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The HVAC equipment manufacturer's representative familiar with system integration and the ATC subcontractor familiar with programming must be present.
- F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the HVAC equipment systems' integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.
- G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record.

1.22. FUTURE ADDITIONS

- A. Where future additions are indicated, size and install all piping to account for future additions. Furnish and install shut-off valves and balance valves in ceiling adjacent to future additions. Provide cap at the end of the piping. Arrange so that in the future the cap can be removed and shut-off valve opened to serve future addition without draining system.

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

- A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 23 with the

work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 23. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 23.

- B. All electrical work performed under Division 23 shall conform to the applicable requirements of Division 26 and conforming to the National Electrical Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the International Building Code.
- C. Provide wiring diagrams with electrical characteristics and connection requirements.
- D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.
- E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.
- F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.
- G. Motors located in exterior locations, wet air streams, air cooled condensers, and outdoors shall be totally enclosed weatherproof epoxy-treated type.
- H. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- I. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.
- J. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. MOTORS AND CONTROLS

- A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.
- B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG 1.
- C. Motors used with variable-frequency controllers shall have ratings, characteristics, and

features coordinated with and approved by the variable frequency controller (drive) manufacturer. As a minimum the following shall apply to variable frequency controlled motors:

1. Motors shall be manufactured to withstand peak voltages of 1600 volts with .1 microsecond rise time per NEMA MG-1.
 2. Critical vibration frequencies of motor shall not be within operating range of variable frequency controller output.
 3. Temperature rise: Match rating for Class B insulation.
 4. Insulation: Class F.
 5. Thermal Protection: Conform to MG1 requirements for thermally protected motors.
- D. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.
1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.
 2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR2 of the driven equipment to operating speed.
 3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
 4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.
 5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.
- E. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of such mechanical equipment as fans, unit heaters, humidifiers and damper controllers. When approved by the Engineer, deviations from the specifications will be permitted as follows:
1. Open motors may be installed as part of an assembly where enclosure within a

cabinet provides protection against moisture.

2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.
- F. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.
- G. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent
20HP	93.0 percent	86 percent
25HP	93.6 percent	85 percent

- H. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient

Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

- I. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.
- J. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.
- K. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.
- L. Provide manufacturer's warranty for all motors for minimum of 5 years including all labor and materials.

2.3. MOTOR INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.
- C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.
- D. Use adjustable motor mounting bases for belt-driven motors.
- E. Align pulleys and install belts.
- F. Tension belts according to manufacturer's written instructions.

2.4. WIRING DIAGRAMS

- A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.
- B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.
- C. Provide wiring diagrams for all major mechanical items of equipment to electrical contractor and ATC subcontractor for coordination.

2.5. VARIABLE FREQUENCY DRIVE MOTOR BEARING PROTECTIVE RINGS:

- A. For all motors driven by a variable frequency PWM drive include a maintenance free, circumferential, conductive micro fiber shaft grounding ring to discharge shaft currents. Grounding rings shall be manufactured by AEGIS SGR or approved equal.
- B. Furnish units with one year warranty.

- C. Size and select Bearing Protective Rings per the manufacturer requirements based on the motor size, shaft diameter, and shaft shoulder length. For motors with slingers furnish and install NEMA /IEC kit as required.
- D. Furnish and apply Colloidal silver shaft coating to all shafts with Bearing Protective Rings to improve shaft voltage discharge capability.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical 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.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- G. Do not install equipment, ductwork, or piping over electrical gear, electrical panels, motor controllers, and similar electrical equipment. Install equipment, ductwork, and piping to maintain clear space above and in front of all electrical components per the National Electric Code.

3.2. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.
- C. Concrete housekeeping pads and foundations shall be not less than 4 inches high (6 inches for high for boilers) and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.3. PROVISIONS FOR ACCESS

- A. The contractor shall provide access panels and doors for all concealed equipment, valves, strainers, dampers, filters, controls, control devices, cleanouts, fire dampers, damper operators, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.
- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Mark each access door within finished spaces with a small color coded and numbered tab. Provide a chart or index for identification. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.
 - 1. Acoustical or Cement Plaster: Style B
 - 2. Hard Finish Plaster: Style K or L
 - 3. Masonry or Dry Wall: Style M
- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.
- F. Where access doors are installed in wet locations (i.e. shower rooms, toilet rooms, natatoriums, kitchens, dishwasher rooms, can wash rooms, and similar spaces, etc....) provide aluminum access doors/frames.

3.4. PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-

applied paints shall be baked enamel with proper pretreatment.

- D. Protect all finishes and restore any finishes damaged as a result of work under Division 23 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed.
- F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exposed ductwork, piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.
- H. All exterior roof mounted ductwork, equipment, piping, breeching, and vents shall be painted to match roof in color as selected by Architect.
- I. All exposed ductwork, piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.
- J. All exposed ductwork, piping, equipment, etc., in Mechanical Rooms, Boiler Rooms, Penthouses, Mezzanines, and Storage where PVC jacketed shall not require painting. Label and identify and color code as specified.

3.5. CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.
- B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of Service Company used.
- C. Maintain strainers and dirt pockets in clean condition.
- D. Clean fans, ductwork, enclosures, flues, registers, grilles, and diffusers at completion of work.
- E. Install filters of equal efficiency to those specified in permanent air systems operated for temporary heating during construction. Replace with clean filters as specified prior to acceptance and after cleaning of system.
- F. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- G. Leave systems clean, and in complete running order.

- H. All HVAC piping/equipment strainers must be pulled and cleaned prior to substantial completion. In addition six (6) months after substantial completion all HVAC piping/equipment strainers must be pulled and cleaned a second time. Document and submit verification of strainer cleaning to Engineer, Owner, and Construction Manager/ or General Contractor.

3.6. COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.
- B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.7. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping, ductwork, and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.8. OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
- C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.
- D. Do not use mechanical systems for temporary services or temporary conditioning during construction, unless approved by Owner in writing. Refer to Division 01 Section "Temporary Facilities and Controls" for temporary heating/cooling during construction.
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.9. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record demonstration and training video recordings. Record each training module separately.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
- D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

- A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
- B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as “Normally Open” or “Normally Closed” as required.
- C. All items of equipment, including motor starters, disconnects and ATC panels shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal).
- D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the Record and Information Booklet as hereinafter specified.
- E. All lines piping and ductwork installed under this contract shall be stenciled with direction of flow arrows and with stenciled letters naming each pipe and ductwork and service. Refer to Division 23 Section, “HVAC Piping, Fittings, Valves, Etc.” and Division 23 Section, “HVAC Air Distribution”. Color-code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.
- F. Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit samples of equipment identification cards, piping labels, ductwork labels, and

valve tags to Engineer for review prior to installation.

- G. Provide at least 8 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section, "Instrumentation & Controls of HVAC & Plumbing Systems".
- H. Contractor shall demonstrate Sequences of Operation of all equipment in presence of Owner's representative, Engineer, and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

- A. All penetrations of partitions, ceilings, roofs and floors by ducts, piping or conduit under Division 23 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 23 Section, "Vibration Control for HVAC, Plumbing and Fire Protection Equipment".
- B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, "Fire Protection, HVAC & Plumbing Penetration Firestopping".
- C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.
- D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.
- E. Piping sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.
- F. Ductwork sleeves: 20 gauge galvanized steel.
- G. Extend all floor sleeves through floor at least 3/4-inches above finished floor, caulk sleeve the entire depth and furnish and install floor plate.

3.12. RECORD DRAWINGS

- A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the GENERAL CONDITIONS.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner.
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
 - 3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
 - 4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

- A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Record and Information Booklet.
- B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared six (6) hardcopies and one (1) electronic copy of the Operations and Maintenance Manuals and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.
- B. The booklet shall be bound in a three ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: Operations and Maintenance Manuals – Owens Campus Automotive Training Facility - HVAC. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

- C. Provide the following data in the booklet:
1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 3. Complete catalog data on each piece of heating and air conditioning equipment furnished including approved shop drawing.
 4. Manufacturer's extended limited warranties on equipment including but not limited to boiler breeching, fuel oil tanks, variable frequency drives, air conditioning compressors, storage tanks ,and heat pumps.
 5. Chart form indicating frequency and type of routine maintenance for all mechanical equipment. The chart shall also indicate model number of equipment, location and service.
 6. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
 7. Provide supplier and subcontractor's names, address, and phone number.
 8. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
 9. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass.
 10. Copy of the approved balancing report including duct leakage data.
 11. ATC systems including as-built ATC drawings of systems including internal of all panels.
 12. Access panel charts with index illustrating the location and purpose of access panels.
 13. Approved Health Department, Boiler Inspector, and Electrical Certificates.
 14. Start-up reports for equipment.
 15. Water treatment test reports.
 16. Provide and install in locations as directed by Owner, filter charts, including filter type, size, model number, manufacturer, quantity and size for each filter utilized on the project. Filter charts shall be enclosed in a durable polymer based frame with a cover safety glass.
 17. Insert color graphic with embedded parameters for ATC system into record and

information booklet.

18. Filter charts indicating equipment served, size, and type of filter required.
 19. Documentation of strainer pulling and cleaning.
- D. Submit Record and Information Booklets prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Record and Information booklets be reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:
1. Complete Ductwork, Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.
- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.
- D. Refer to Division 01 Section "Project Management and Coordination" for additional requirements related to coordination drawings.

3.17. PIPING SYSTEMS TESTING

- A. The entire new HVAC piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Heating, Water Supply & Return Piping, Including Chemical Treatment Piping	100 psi
Refrigerant Piping	550 psig with Nitrogen

- B. Ductwork pressure testing shall be as specified in another division of these specifications.
- C. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the Operations and Maintenance Manuals.
- D. Refrigerant piping shall be tested utilizing nitrogen per equipment manufacturer's

requirements.

3.18. EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

3.19. ADDITIONAL FILTERS AND BELTS

- A. One complete set of additional filters and belts shall be turned over to the owner upon final acceptance of the building by the owner. Provide correspondence to the Engineer (copy) documenting that additional filters and belts have been turned over to Owner.
- B. All filters and belts shall be tagged and identified for equipment served. Furnish filters in protection wrap.

3.20. STRAINER CLEANING

- A. All equipment strainers must be pulled and cleaned at substantial completion. Document in writing and via digital photographs that all strainers have been pulled and cleaned.
- B. One year after project substantial completion all strainers shall be pulled again and cleaned. Document in writing and via digital photographs that all strainers were pulled and clean at the one year after project substantial completion data.
- C. Insert documentation that the strainers have been pulled and cleaned in the Record and Information Books.
- D. Re-purge hydronic systems of all air after strainers are pulled and cleaned.

3.21. OUTAGES

- A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.
- B. Submit Outage Request form, attached at end of this Section, to Owner for approval.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE -- TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____

(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ___ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ___ NO: ___ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

SECTION 230505 - HVAC PIPING, FITTINGS AND VALVES

PART 1. GENERAL

1.1. SUMMARY

- A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, Common Work Results for HVAC and Division 01, General Requirements.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.
- B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and International Building Code (IBC).
- C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- F. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.
- G. Use spring loaded "silent" check valves on discharge of all pumps.
- H. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- I. At all runout piping serving equipment, use swing joints with elbows to prevent excessive movement of piping due to expansion.

1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.

- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- C. Welders Certification: In accordance with ASME Section 9.
- D. 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.
 - 1. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
- E. Maintain one copy of each document on site.

1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.6. EXTRA MATERIALS

- A. Provide one (1) repacking kit for each size valve.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.
 - 1. Heating Water Supply & Return Piping and Chemical Treatment Piping (Inside of Building):

- a. Pipe: Schedule 40 Black steel pipe, ASTM A53
1-1/2 inch and smaller - Type F, ASTM A53 steel (CW) with threaded joints
2 inch and larger - Grade B, Type E, ASTM A53 steel (ERW) with welded, flanged or grooved joints.
- b. Fittings & Joints: 2-1/2 inches & larger, schedule 40 wrought steel ASTM A234 Grade WPB or Std. B16.9 long radius welding; factory-fabricated from ASTM A53 pipe; or ASTM A536 ductile iron; 2 inches & smaller 125 lb. std. cast iron screwed, ASTM Standard B16.4; or Vic-Press precision, cold drawn, stainless steel with elastomer O-ring seals. Joints shall be threaded or AWS D1.1 welded. Victaulic, Apollo/Shurjoint, or approved equal grooved joints shall be acceptable.
- c. Flanges: Wrought steel Class 150 welding neck. ASTM Standard B16.5.
- d. Grooved Joint Couplings: Two ductile iron housings, pressure responsive elastomer gasket, and ASTM A449 zinc electroplated steel bolts and nuts. Couplings shall comply with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
 - i. Rigid Type: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ASNI B31.1 and B31.9.
 - 1) Victaulic Style 107H, Apollo/Shurjoint Z-07, Installation-Ready or approved equal, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 degrees F.
 - ii. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors. Victaulic Installation-Ready Style 177 or Style 77, or approved equal.
 - iii. 14" and Larger: AGS Series, two segment coupling with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible), Apollo/Shurjoint 7707/7707N, or approved equal.
 - iv. Flange adapters shall be suitable for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741/W741, Apollo/Shurjoint 7041, or approved equal.
 - v. Rolled form grooves only. Cut grooves are prohibited.
 - vi. Verify gasket compatibility on Chemical Treatment piping.
- e. Gate Valves: 2-1/2 inches & larger - IBBM, 150 lb. OS&Y grooved end or flanged; 2 inches & smaller - 150 lb. Bronze body bronze trim. Basis of Design: Victaulic Series 771V or approved equal.
For valves 4 inch and larger located in mechanical equipment spaces 10 feet-0 inch or greater above finished floor, valve shall have chain wheel operators with chains extending to within 6 feet-0 inch above finished floor. Chain wheels and guides shall be galvanized.
- f. Ball Valves: Shut-off valves 2 inches and smaller shall be ball valves. Ball valves shall be 600cwp, 150swp full port, with RPTFE seats, chrome plated ball and stem 2 1/2 and larger, class 125 cast iron OS&Y IBBM gate valve, brass or bronze body, standard port, 2 piece body. Ball valves shall be VicPress end, threaded end or solder end as required to accommodate piping. Ball valves shall be as manufactured by Victaulic, Crane, Apollo,

- Nibco, Watts or engineer approved equal.
- g. Globe Valves: 2-1/2 inches & larger – IBBM 125 lb.std. flanged, with No. 1 disc; 2 inches & smaller - bronze 150 lb. std. screw ends, with #1 disc.
 - h. Check Valves: 2-1/2 inches & larger – IBBM or stainless steel trim, 125 lb.std. grooved end or flanged spring-assisted swing check suitable for vertical or horizontal installation, with metal disc; 2 inch & smaller - 125 lb. std. screwed. Provide "silent" spring loaded check valves at all pump discharges. Victaulic Series 716/W715 or approved equal.
 - i. Balancing Valves: Victaulic Series 377/365, DeZurik Series 100, Fig. 118 or approved equal, ductile iron or cast iron construction, stainless steel bearings, nickel seats (3 inches and larger) non-lubricated, eccentric plug with EPDM, chlorobutyl rubber or Bunz-N resilient faced plugs suitable for 230 degrees F, semi-steel screwed with fig. 159, removable lever and open. nut for valves 3 inches and smaller. For valves 4-inch and larger, provide gear operators and grooved ends or flanged connections. Provide chain operated valves for sizes 4-inches and larger located 10 feet-0 inches or more above finished floor. Chains shall extend to within 6 inch-0 inches above finished floor. All valves shall have adjustable memory stop. Chain wheel and guide shall be galvanized.
 - j. Butterfly Valves: Victaulic Vic300 MasterSeal/ AGS-Vic300, DeZurik, Apollo 215L series, high performance or Keystone K-Loc, type with infinite position lever (for 3-inches and smaller) and pressure-responsive seat or double seat type and memory stop. Provide gear operator on valves 4-inches and larger.
 - i. Valve stem shall be stainless steel, and shall be offset from the disc centerline to provide complete 360 degree circumferential seating.
 - ii. Valve shall be rated to +250 deg F in sizes through 12-inches.
 - iii. Seat shall be elastomer, of a grade suitable for the intended service. The seat shall be pressure responsive in sizes through 12 inches.
 - iv. For valves 4 inches and larger located 10 feet-0 inches or more above finished floor shall be provided with chain operators with chains extending to within 6 feet-0 inches above finished floor. Chain wheel and guide shall be galvanized.
 - k. Combination Shut-off/Balancing Valves:
Victaulic/ TA Hydronics, Taco Circuit Setter, Bell & Gossett Circuit Setter Plus, Flowset Accuset, Gerand, or as approved equal, 2-inch-3-inch 300 lb. rated Ametal (copper-alloy) body globe type or ball valve with bronze body/brass ball construction with glass and carbon filled TFE seats, in-line flow meter and balancing and shut-off valve with built in ball valve for flow adjustment. Valve shall have memory stop, calibrated nameplate, Schrader valve connections and preformed molded insulation. Valves shall be leaktight at full rated working pressure. Balance valve size shall be selected based on manufacturer's acceptable flow range and design flow rate. Pressure drop through combination shut off balance valves shall not exceed 5 feet of head at design flow rate.
 - l. Extended Valve Stems: Provide and install round collar type extended valve stems on all valves installed in insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve

- handles outside of insulation.
- m. Alternate:
- i. At contractors option all HVAC water supply and return lines may be copper type L (ASTM Std. B88) with wrought copper fittings (ASTM Std. B 16.22) with brazed or 95-5 silver solder joints lead and antimony based solders are prohibited and all bronze valves may be used on piping 2 inches and less in size.
 - ii. At Contractors option, Viega Pro Press/ Mega Press, or Apollo Press/Apollo Power Press, Pressure Seal mechanical fittings may be utilized. Viega, ProPress Pressure Seal Fittings: Bronze or copper shall conform to ASME B16.51, ICC LC 1002, and IAPMO PS 117. ProPress fittings ½-inch thru 4- inch for use with ASTM B88 copper tube type L and ½-inch up to 1-1/4-inch annealed copper tube. ProPress fittings shall have an EPDM sealing element and Smart Connect (SC) feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) feature.

2. Refrigeration Piping:

- a. Concealed: Tube Size ¾ -inch & Smaller:
ASTM B280, copper tube; Type ACR, soft annealed temper fittings; cast copper-alloy fittings for flared copper tubes; flared joints. Fittings shall be ASME B16.22, wrought copper. Joints shall be brazed, AWS A5.8, BCUP silver/phosphorous/copper alloy with melting range 1190 to 1480 degrees F.
- b. Concealed: Tube Size 7/8 inch through 4-1/8inches:
Copper tube, Type ACR, soft annealed temper; wrought-copper, brazed-joint fittings; brazed joints.
- c. Exposed: Tube Size ¾ Inch and Smaller:
Copper pipe, Type ASTM B88, Type K with brazed wrought-copper fittings conforming to ASME B16.22. Filler metal shall be brazing type conform to AWS A5.8.
- d. Exposed: Tube Sizes 7/8 Inch and Larger:
Copper pipe, Type ASTM B88, Type K with brazed wrought-copper fittings conforming to ASME B16-22. Filler metal shall be brazing type conforming to AWS A5.8.
- e. Braze Joints: Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal.
- f. Flexible connectors: 500-psig (3450-kPa) minimum operating pressure; stainless-steel core and high-tensile stainless-steel-braid covering; dehydrated, pressure tested, minimum 7 inches (180 mm) long.
- g. Diaphragm Packless Valves:
500-psig (3450-kPa) working pressure and 275 degrees Fahrenheit (135 degrees C) working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.
- h. Packed-Angle Valves: 500-psig (3450-kPa) working pressure and 275 degrees Fahrenheit (135 degrees C) working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating,

- rising stem and seat, molded stem packing, and with solder-end connections.
- i. Check Valves: Smaller than NPS 1 (DN 25): 400-psig (2760-kPa) operating pressure and 285 degrees Fahrenheit (141 deg Celsius) operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with brazed-end connections.
 - j. Check Valves: NPS 1 (DN 25) and Larger: 400-psig (2760-kPa) operating pressure and 285 degrees Fahrenheit (141 deg Celsius) operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained polytetrafluoroethylene seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.
 - k. Service Valves: 500-psig (3450-kPa) pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with brazed-end connections.
 - l. Service valves for VRV branch selector boxes and indoor heat pumps shall be bi-directional Sporlan model EBVT with access fitting. Valves shall be rated for 700psig, shall be U.L. listed, suitable for full refrigeration service temperature range of -40°F to 325°F. Valves shall include the following additional features:
 - i. Welded body joint with forged brass body construction with extended copper fittings.
 - ii. Dual Teflon seals.
 - iii. Full size ports to minimize pressure drop.
 - iv. ¼ turn operation with stainless steel stop plate.
 - v. Internal ball relief port to allow positive shut-off in either direction, even during system evacuation.
 - vi. Suitable for R-410A refrigerant.
 - vii. Date code stamped into valve body.
 - m. Solenoid Valves: Comply with ARI 760; 250 deg Fahrenheit (121 deg Celsius) temperature rating and 400-psig (2760-kPa) working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and brazed-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch (16-GRC) conduit adapter and 24-V, normally closed holding coil.
 - n. Pressure-Regulating Valves:

Comply with ARI 770; pilot operated, forged brass or cast bronze, stainless-steel bottom spring, pressure-gage tapings, 24-V dc standard coil, and wrought-copper fittings for brazed-end connections; suitable for refrigerant specified.
 - o. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting.
3. Cooling Coil A/C Condensate Drain and Floor Drain Piping that is Collecting A/C Condensate Piping:
- a. Pipe & Fittings: All A/C condensate drain piping, including floor drain piping that is collecting A/C condensate, shall be constructed of Type L copper tubing, with sweat fittings made with 95-5 solder. Washout plugs

(cleanouts) shall be strategically located to allow periodic flush out of system. At a minimum, provide washout plugs at equipment connections and at direction changes of 90 degrees F or greater.

- b. Firestopping at all pipe penetrations of rated or smoke barrier walls.
- c. Provide backwater valve (ball float type) at connections of condensate piping to stormwater piping and air gap fitting. Backwater valve shall be Model Z1099 as manufactured by Zurn or approved equal. Backwater valve shall have drain coated cast iron body, plastic ball float, bronze backwater bushing and replaceable neoprene seat.

4. Gas Fired Condensing Boiler Condensate Piping

- a. Piping shall be PVC pipe, ASTM D1785 schedule 40 with ASTM D2466 socket fittings for schedule 40. Join PVC pipe/fittings utilizing solvent cement ASTM D2564 with ASTM F656 primer.
- B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.
- C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.
- D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS, ROLLER SUPPORTS, ANCHORS, GUIDES, AND SADDLES

- A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe 3/4-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - 1/2	6	8	3/8
2	8	8	3/8
2 - 1/2	10	9	1/2
3	12	10	1/2
4	14	12	5/8
5	14	12	5/8
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
12	20	18	7/8

- B. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.
- C. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
- D. Hangers for cold pipe sizes 2 inches (50 mm) and over: Carbon steel, adjustable, clevis.
- E. Hangers for cold pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
- F. Hangers for cold pipe sizes 6 inches (150 mm) and over: adjustable steel yoke, cast iron roll, double hanger.
- G. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.
- H. Multiple or Trapeze hangers for hot pipe sizes 6 inches (150 mm) and over: Steel channels with welded spacers and hanger rod, cast iron roll.
- I. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook
- J. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp.
- K. Wall support for hot pipe sizes 6 inches (150 mm) and over: welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- L. Vertical Support: Steel riser clamp.
- M. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

- N. Floor support for hot pipe sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- O. Floor support for hot pipe sizes 6 inches (150 mm) and over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- P. Copper pipe support: Carbon steel ring, adjustable, copper plated.
- Q. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- R. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- S. For exterior pipe supports provide stainless steel brackets and anchors.

2.3. HYDRONIC EXPANSION LOOPS

- A. Provide hydronic flexible expansion loops of size and material noted on drawings as manufactured by Metroloop or approved equal. Flexible loops shall be designed to impart no thrust loads on the anchors. The loop shall consist of two flexible sections of hose and braid, two 90 degree elbows, and a 180 degree return. Loops shall be installed in a neutral, precompressed, or pre-extended condition as required for application. Loops are to be installed within four pipe diameters, both upstream and downstream, from a pipe guide.
- B. Where indicated provided nested loops and support the 180 degrees return bend. Nested loops shall be sized to absorb the axial compression movement as scheduled on the contract drawings.

2.4. VALVES

- A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer.
- B. Check valves in base mounted pump discharges shall be of the vertical type and shall be Victaulic Series 716/ W715, Miller "non-slam" check valves, Apollo/Shurjoint SJ-900, or approved equal suitable for service intended. Check valves in circulator discharges shall be horizontal type.
- C. Provide at each base mounted pump a suction diffuser of size and type shown on drawings. Units shall consist of a ductile cast iron angle type body with inlet vanes, magnetic insert, and blowdown connection tapped gauge post, 125 psi ANSI flange and a combination stainless steel diffuser strainer with 5/32 or 3/16-inch diameter opening for pump protection. Unit shall be equipped with a disposable fine 20-mesh stainless steel start up strainer which shall be removable after 30 days. Flow direction shall be from inside the strainer to outside for ease of service and cleaning. The body shall fit the pump and connecting pipe size. The unit shall be provided with a base support boss or an adjustable support foot to relieve piping strains from the pump suction. Suction diffuser shall be Victaulic 731 Series, Taco "SD" Series Catalog 300-4.1, Bell and Gossett Model FLG, Armstrong, Patterson, Apollo/Shurjoint 725F, or engineer approved equal.

- D. Multi-purpose valve (non-slam check valve, throttling valve, shut-off valves and calibrated balancing valve) shall be provided at discharge side of constant speed pumps. The valve shall be of heavy-duty cast iron construction with standard ANSI flanged connections and rated for a maximum working pressure of 175 psig at 240oF. The valve shall be fitted with a stainless steel stem or stem sleeve and brass seat with "O" ring seal. Valve shall be Taco "Plus One" Number 300-4.2, Bell and Gossett 3DS Triple Duty Valve, Armstrong, Patterson, or as approved equal, and shall have check and plug valve features plus a memory stop with pointer and scale. Provide additional shut-off valve to allow servicing of check valve if a multipurpose valve is utilized in lieu of separate check, shut-off, and balance valve. Provide additional shut-off valve downstream of multi-purpose valve to allow servicing of multi-purpose check valve feature. Provide pre-manufactured, removable insulation covers for all multipurpose valves.
- E. Triple Duty Valve Assembly: Assembly shall consist of a Victaulic Master Seal, Apollo/Shurjoint SJ-900, or approved equal butterfly valve with memory stop and a Series 779 Venturi-Check, rated for water service to 230 degrees Fahrenheit (110 degrees Celsius) and pressures to 300 psig (2065-kPa).
 - 1. For 14" through 24" sizes, Victaulic AGS-Vic300, Apollo/Shurjoint SJ-300N-L/SJ-300N-W, or approved equal butterfly valve with Series W715 AGS check valve, rated for pressures to 230 psig (1575-kPa).
- F. Do not install multipurpose valves or balance valves on the discharge of variable speed pumps.

2.5. STRAINERS

- A. Strainers shall be of the basket or "Y" type and shall be heavy and durable, constructed of ductile iron to ASTM A536 or the best grade gray iron with the bottoms drilled and plugged. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and brass sediment baskets made of stainless steel or brass not less than #22 gauge in thickness. Total area of basket perforations shall be not less than four times the cross section of the entering pipe. Flow shall be into basket, and then out through the perforations. Strainers shall be suitable for water or the intended fluid. Strainers 2 inches and smaller shall have threaded or solder ends, 2 inches and larger shall have flanged ends.
- B. Strainer screens shall be stainless steel with perforations and shall be 1/16-inch for pipe sizes 5 inches and less, 1/8-inch (40 percent open area) perforations for pipe sizes 6-inch and greater.
- C. Provide valved and capped (with chain) blowdowns in each strainer. Blowdown valves shall be Apollo 78-100/200 series or as approved equal.
- D. Strainers shall be manufactured by Victaulic Style 732/W732, Watts, Mueller, Armstrong, Yarway, Spirax/Sarco, Apollo/Shurjoint 726, or as approved equal.

2.6. UNIONS, FLANGES, AND COUPLINGS

- A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.

- B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.
- C. Unions in stainless steel pipe 2-inches and smaller shall be hexagonal threaded type stainless steel unions, with VicPress ends. Basis of Design: Victaulic Style P584.
- D. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.
- E. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.7. MANUAL AIR VENTS

- A. Manual air vents shall be similar to the hereinafter specified gauge valves. Provide 1/4-inch size on 3/4-inch pipe and smaller, 1/2 -inch size on 1-inch pipe and larger. Install at all high points of piping. Valves shall be Crane No. 88, or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.8. AUTOMATIC AIR VENTS

- A. Provide at air separators, expansion tanks and where shown on the drawings, float actuated non-modulating high capacity air vent to purge free air from the system and provide a positive shut-off at pressures up to 150 psig at a maximum temperature of 250 degrees Fahrenheit. The high capacity air vent shall prevent air from entering the system if the system pressure drops below atmospheric pressure. The air vent shall be pilot operated for intermittent purging of free air up to pressures of 2 psig during normal system operation and diaphragm operated for full capacity purging of free air at pressures between 2 and 150 psig. The high capacity air vent shall be constructed of cast iron and fitted with components of type 313 stainless steel, brass, EPDM and silicone rubber. Pipe discharge to closest floor drains with Type K copper tubing. The high capacity vent shall be Model 107 by Bell and Gossett, Model 13w by Spirax Sarco, Taco, Spirotherm Spirotop, or as approved equal.

2.9. THERMOMETERS

- A. Unless otherwise indicated, thermometers shall be ASTM E1, in a glass type, organic filled, 9-inch scale size, corrosion-resistant metal case, with "any-angle" mounting with positive locking device. Terrice Industrial Thermometers, Weksler Instruments, Ernst Gage Co., Miljoco, or approved equal. Insertion stem length shall suite the pipe size and configuration. Thermometer wells shall be brass with brass union hubs in copper and in ferrous piping. Where piping is insulated or otherwise covered, use wells with lagging extension. Where wells are installed in pipe tees at turns, increase pipe size so that well does not restrict flow. Accuracy shall be 2 percent.
- B. Unless otherwise indicated, thermometer ranges shall be as follows:
 - 1. Heating Water: 30 degrees Fahrenheit to 240 degrees Fahrenheit, 2 degrees Fahrenheit Division.
- C. Provide heat conducting compound in wells.

2.10. PRESSURE GAUGES

- A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.
- B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.
- C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.
- D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.
- E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.11. FLOW METERS

- A. Griswold or Bell & Gossett Venturi disturbed flow measurement quickset flow meters shall be utilized in lieu of sentinel type flow meters. Units shall consist of a spun steel venturi welded into the pipe. Disturbed fluid shall be channeled through the throat of the venturi with a multi-point Piezo Ring. Accuracy shall be $\pm 1\%$ PSID with no straight pipe run required. Furnish differential pressure gauge supplied with carrying case and hoses.

2.12. PIPING SPECIALTIES

- A. Furnish and install flexible pipe connections, as specified and/or shown on the drawings, at suction and discharge connections of all base mounted and vertical in-line pumps, connections to air handlers, connections to energy recovery ventilators, all vibrating equipment, and elsewhere as shown. Refer to Division 23 Section, Vibration Controls for HVAC, Plumbing and Fire Protection Equipment for specifications.
- B. Pressure relief valves shall be provided in the number and sizes required to relieve 110 percent of the full input to the systems. Valves shall be rated; and installed in accordance with ASME, and CSD-1 including all amendments. Pipe discharge full size to floor drain, (with union) and support discharge pipe to prevent exerting any strain on relief valve body, piping to be Type-L copper. Water safety relief valves shall be Watts Series 740, Conbraco, Series 154A, Bell and Gossett, or approved equal. Provide pressure gauge adjacent to all safety relief valves.
- C. Gas relief valve piping shall be sized and installed in accordance with the latest edition of ASME Boiler & Pressure Vessel Code, CSD-1 including amendments. Pipe material shall be as specified for gas piping. Gas relief valve piping material shall be the same as

hereinbefore specified for gas piping.

2.13. ESCUTCHEONS

- A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.
- B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.14. DIELECTRIC CONNECTIONS:

- A. Furnish and install electrically insulated dielectric waterway fittings, unions or flanges, as manufactured by Victaulic Company Style 47, EPCO Sales, Inc., or approved equal at the following locations:
 - 1. Where steel piping systems join copper piping.
 - 2. Where copper tube connects to domestic water storage tanks, water heaters, heat exchangers, expansion tanks, and other steel vessels.
 - 3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.
 - 4. Dielectric Waterway: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. UL classified in accordance with NSF-61 for potable water service, and shall meet the low-lead requirements of NSF-372. Basis of Design: Victaulic Series 647.

2.15. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.
- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend 3/4-inch above the floor. Refer to Division 23 Section, Vibration Controls for HVAC, Plumbing and Fire Protection Equipment for mechanical equipment room penetrations additional requirements. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.
- C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.
- D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.16. PRESSURE REDUCING VALVES

- A. Provide pressure reducing valves as indicated, of size and capacity selected by the installer to maintain operating pressure on the system. Body shall be cast-iron or bronze construction, renewable stainless steel seat, non-corrosive disc, water tight cage assembly, adjustable pressure ranges and inlet strainer Watts Regulator Model 223-S, Armstrong, Bell and Gossett, Apollo 36LFPR, or as approved equal.
- B. Provide pressure gauge adjacent to all pressure reducing valves to verify proper set point.

2.17. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees Fahrenheit.

2.18. TEST PLUGS

- A. Where indicated, furnish and install P/T plugs or Pete's Plugs as manufactured by IMAC Systems or approved equal.
- B. Description: Nickel-plated, brass-body test plug in NPS 2 (DN15) fitting. Test plugs shall be as manufactured by Trerice, Watts, Natural Meter, Apollo Brass Test Plugs, or approved equal. Test-station fitting made for insertion in piping tee fitting.
- C. Body: Length as required to extend beyond insulation. Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS ¼ (DN 8) or NPS ½ (DN15) as required, ASME B1.20.1 pipe thread.
- E. Pressure Rating: 500 psig minimum.
- F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- G. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8 inch OD probe from dial-type thermometer or pressure gage. Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.
- H. Core Insert: Self-sealing valve, suitable for inserting 1/8 inch OD probe from dial-type thermometer or pressure gage.
- I. Core Material for Air, Water, Oil, and Gas: 20 to 300 degrees F chlorosulfonated polyethylene synthetic rubber.
- J. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

- K. Pressure Gage and Thermometer Ranges: approximately two times the system's operating conditions.
- L. Self-closing valves with caps and retaining straps.

2.19. FLO-CONTROL VALVES

- A. Furnish and install flo-control valves as shown on contract drawings to prevent gravity circulation in forced hot water systems. Flo-control valves shall be Bell & Gossett flo-control valves, TACO flo checks, or approved equal.
- B. Flo-control valves shall be suitable for installation in vertical or horizontal piping. Disc shall be precision machined bronze. Valve seats shall be heavy wall brass. Flo-control valves shall be suitable for a maximum operating temperature of 275 degrees F and a maximum working pressure of 125 psig. Flow-control valves shall not be selected based on line size. Select flow-control valves at design flow rate to limit pressure drop to 6 Ft head.
- C. Flo-control valves shall be constructed to allow cleaning without breaking pipe connections. Flo-control valves shall be installed with clearances from center line of valves to ceiling as required by manufacturer. Flo-control valves shall feature a manual open position for gravity circulation.

2.20. TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - 2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.
- D. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one

of the following:

- a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All horizontal mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.
- B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.
- C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.
- D. All valves, strainers, caps, and other fittings shall be readily accessible.
- E. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.
- F. Discharge lines from all relief valves shall be piped to within 4-inches of floor and extend to floor drains wherever floors are not pitched to drains. Pitch the relief valve piping away from the relief valve to insure that no fluid can be trapped in valve discharge. Support all relief valve piping to prevent exerting strain on the relief valve body. The end of the relief valve discharge piping shall not be threaded to prevent capping or plugging.

- G. All branches from water mains shall be taken from the top of the supply mains at an angle of forty-five (45) degrees above the horizontal, unless otherwise directed. Branches feeding down shall be taken from the side or bottom of the main on water mains only. All connections shall be carefully made to insure unrestricted circulation, eliminate air pockets or trapped condensate, and permit the complete drainage of the system.
- H. Cutoff valves shall be provided on each branch line from the mains on all heating/air conditioning lines.
- I. Shut-off valves shall be installed at the inlet and outlet of each coil and piece of equipment to permit isolation for maintenance and repair. Units having multiple coils shall have separate valves for each coil.
- J. Balancing valves shall be installed in all heating/air conditioning water branches and at all pumps, and where indicated on the drawings.
- K. Unions shall be installed on all bypasses, ahead of all traps, at all connections to equipment, where shown on drawings or where required to facilitate removal of equipment whether shown or not.
- L. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.
- M. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.
- N. Approved expansion loops shall be provided to permit free expansion and contraction of all piping systems.
- O. Install all valves with stem upright or horizontal, not inverted.
- P. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.
- Q. Provide clearance for installation of insulation and access to valves and fittings.
- R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- S. All water containing pipes shall be routed clear of combustion air dampers and louvers to prevent freezing condition when dampers are open.
- T. Provide manual air vents at top of piping systems.

3.2. THERMOMETER AND PRESSURE GAGE INSTALLATION REQUIREMENTS.

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install separable sockets in vertical position in piping tees where fixed thermometers are

indicated.

1. Install with socket extending to one-third diameter of pipe.
 2. Fill sockets with oil or graphite and secure caps.
- C. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.
- D. Adjust faces of thermometer and gages to proper angle for best visibility.
- E. Clean windows of thermometer and gages and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. 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.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. 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.
- F. Do not attempt to repair defective valves; replace with new valves.
- G. Install valves as indicated, according to manufacturer's written instructions.
- H. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- J. Locate valves for easy access and provide separate support where necessary.
- K. Install valves in horizontal piping with stem at or above the center of the pipe.
- L. Install valves in a position to allow full stem movement.
- M. For chain wheel operators, extend chains to 60 inches above finished floor elevation.

- N. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.
- O. Install flow control valves with clearances from center line of valve to ceiling to allow servicing as required by manufacturer.

3.4. AUTOFLOW CONTROL VALVE INSTALLATION

- A. Install automatic flow control valves on the return lines of coils as indicated on the contract drawings. A balancing valve on supply side is not acceptable.
- B. The standard ports and handles shall clear 1-inch thick insulation. Provide handle and port extensions for all insulation over 1-inch thick. Do not insulate flow control valves used on heating coils.
- C. Install, on the supply side of coils, a Y-strainer (40 mesh, 2 GPM or less; 20 mesh, above 2 GPM) with brass blow down valve with $\frac{3}{4}$ -inch hose-end connection with cap. Inline (basket) strainer is not acceptable.
- D. Where installed in piping with a vapor barrier, field insulate valve body to prevent surface condensation.

3.5. REFRIGERANT PIPING AND ACCESSORIES INSTALLATION REQUIREMENTS

- A. 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 Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. All exposed piping shall be hard copper tubing with brazed joints. Refer to Architectural Contract Documents to determine exposed areas.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to units to allow service and maintenance.
- G. Install piping free of sags and bends. Install VEE clevis hangers and VEE troughs on pipes less than $\frac{3}{4}$ " inch in diameter.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows,

and fittings.

- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed below ground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. 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. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- O. When brazing, 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.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section, "Common Work Results for HVAC".
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section, "Common Work Results for HVAC".
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section, "Common Work Results for HVAC".
- U. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6m) long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6m) or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6m) or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- V. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS ½ (DN 15): Maximum span, 60 inches (1500mm); minimum rod size, ¼ inch (6.4mm).
 2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500mm); minimum rod size, ¼ inch (6.4mm).
 3. NPS 1 (DN 25): Maximum span, 72 inches (1800mm); minimum rod size, ¼ inch (6.4mm).
 4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
 5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
 6. NPS 2 (DN 50): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
 7. NPS 2-½ (DN 65): Maximum span, 108 inches (2700mm); minimum rod size, 3/8 inch (9.5mm).
 8. NPS 3 (DN 80): Maximum span, 10 feet (3m); minimum rod size, 3/8 inch (9.5mm).
 9. NPS 4 (DN 100): Maximum span, 12 feet (3.7m); minimum rod size, 1/2 inch (13mm).
- W. For all interior refrigerant pipe/tubing that is less than 3/4inch in diameter, utilize VEE type clevis hanger Model 200 V and VEE type trough Model 200 VT; as manufactured by Carpenter and Patterson or approved equal. VEE trough materials shall be carbon steel with pre-galvanized finish. Install as required to maintain maximum hanger spacing requirements.
- X. Support multifloor vertical runs at least at each floor.
- Y. Furnish and install complete refrigerant piping systems between the indoor units and outdoor units, branch selector boxes, indoor units, and compressor units. Support piping in accordance with Division 23 Section, HVAC Piping, Fittings, Valves, Etc. Piping shall be sized as recommended by unit manufacturer taking into account length of vertical and horizontal runs, and refrigerant type. Provide and install dual sets of refrigerant piping on

all units required to have dual independent circuits.

- Z. Furnish and install all required piping accessories including, but not limited to, thermal expansion valves, Sporlan, or approved equal; Packless isolation valves at condenser and evaporator coil, Henry or approved equal, charging valve with chained seal cap, Henry or approved equal, sight glasses, Henry or approved equal; filter dryer with replaceable cartridge, Sporlan, or approved equal, liquid line solenoid valve 120V/1/60 Hz., Sporlan, or approved equal. Contractor shall provide traps and double suction risers if required by equipment manufacturer. Pitch piping for proper oil return. Submit shop drawings on all components, and piping arrangements.
- AA. All accessories shall be ARI rated. Furnish required nitrogen and refrigerant to fully test and charge system. Flood piping system with nitrogen when brazing.
- BB. Refrigerant piping shall be Type 1 hard temper (ACR) copper tubing with wrought copper brazed fittings. Make joints with brazed wrought copper fittings.
- CC. Refrigerant piping shall be cleaned, dehydrated and evacuated. Piping shall be evacuated and held to less than 2.5 mm Hg vacuum for a period of not less than 12 hours without appreciable pressure rise. Vacuum shall then be broken with refrigerant or dry nitrogen and re-evacuated to 2.5 mm Hg vacuum for an additional 12 hours. Piping test to be witnessed by Owner's representative and documented in writing. Submit results of tests to Architect/Engineer.
- DD. All refrigerant/suction lines sets shall be fully insulated. Exterior pipe insulation shall be fully jacketed as specified in Division 23 Section, "HVAC Insulation". Exposed interior pipe insulation shall be fully jacketed as specified in Division 23 Section, "HVAC Insulation".
- EE. Follow ASHRAE 15, latest edition procedures for charging and purging of systems and for disposal of refrigerant.
- FF. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- GG. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- HH. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- II. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- JJ. Fully charge completed system with refrigerant after tested.
- KK. Provide electrical connection to solenoid valves.
- LL. Install liquid indicators in liquid line leaving condenser, in liquid line leaving [receiver], and on leaving side of liquid solenoid valves.
- MM. Install strainers immediately upstream from each automatic valve, including expansion

valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

- NN. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.
- OO. Install strainers in suction line of steel pipe.
- PP. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.
- QQ. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.
- RR. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
 - 1. Test refrigerant piping, specialties [and receivers]. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
 - 2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
 - a. System shall maintain test pressure at the manifold gage throughout duration of test.
 - b. Test joints and fittings by brushing a small amount of soap and glycerin solution over joint.
 - c. Fill system with nitrogen to raise a test pressure of 150 psig (1035 kPa) or higher as required by authorities having jurisdiction.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- SS. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- TT. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- UU. Adjust set-point temperature of the conditioned air or chilled-water controllers to the system design temperature.
- VV. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Check compressor oil level above center of sight glass.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves, except bypass valves that are used for other purposes.
 - 5. Check compressor-motor alignment, and lubricate motors and bearings.

- WW. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.
- XX. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.
- YY. Charge system using the following procedures:
 - 1. Install core in filter-dryer after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers (67 Pa). 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 (14 kPa).
 - 4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

3.6. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. **Welded Joints:** Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.
- B. Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.
- C. **Grooved Joints:** 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.)
- D. **Screwed Joints:** All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.
- E. **Soldered Joints and Copper Piping:** Joints in copper piping shall conform to the following minimum standards.
 - 1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all

burrs removed.

2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
 3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
 4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
 5. Solder joints shall be made by using a direct flame from a torch.
 6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
 7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
 8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
 9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.
- F. Where copper piping joins steel piping, approved bronze adapters shall be used.
- G. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

3.7. HANGERS, SUPPORTS, ANCHORS, GUIDES INSTALLATION REQUIREMENTS

- A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal.
- B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.
- C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a

horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.

- D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.
- E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.
- F. Select hangers and components for loads imposed. Secure rods with double nuts.
- G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.
- H. Support overhead piping with clevis hangers.
- I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.
- J. Install guides on piping adjoining expansion fittings and loops.
- K. Attach guides to pipe and secure to building structure.
- L. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- M. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- N. Construct concrete anchors of poured in place concrete of dimensions indicated and include embedded fasteners.
- O. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
- P. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.
- Q. Refer to structural documents for appropriate connection/attachment materials to building.

3.8. AIR VENTING INSTALLATION REQUIREMENTS

- A. The top of each hydronic water supply and return piping and other points as indicated or where necessary for the removal of air from the system or equipment, shall be vented using an approved type of manual air vent.
- B. In addition to manual air vents at high points of system, each item of water heat transfer

equipment shall be manually vented using an approved type manual air vent. All air vents shall be accessible.

3.9. EXPANSION LOOPS AND SWING CONNECTION INSTALLATION REQUIREMENTS

- A. Install expansion fittings according to manufacturer's written instructions.
- B. Install expansion fittings in sizes matching pipe size in which they are installed.
- C. Align expansion fittings to avoid end loading and torsional stress.
- D. Install pipe bends and loops cold sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- E. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.
- F. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- G. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- H. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.10. PIPING IDENTIFICATION INSTALLATION REQUIREMENTS

- A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.
- B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
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½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.11. VALVE IDENTIFICATION REQUIREMENTS

- A. All valves shall be tagged with a numbered tag.
- B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.
- C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.
- D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in each mechanical equipment room including each air handling unit mechanical equipment room. Additional copies shall be provided in each copy of the O&M manuals.

3.12. CLEANING PIPING AND EQUIPMENT

- A. All condensate, heating water, HVAC, systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water and/or where indicated antifreeze solution and purged of all air.
- B. All condensate, heating water, HVAC, piping system shall be flushed clean with fresh water. See Division 22 Sections, Plumbing Fixtures and Plumbing Equipment for domestic potable water cleaning and sterilization.
- C. Any equipment, such as coils that have small tubing, shall be bypassed to prevent deposition of debris from the piping. Water balancing shall not be scheduled until the completion of the cleaning and treatment process.

- D. All strainers shall be inspected and cleaned prior to testing and balancing. In addition, prior to substantial completion, contractor must inspect and clean all strainers.

3.13. PRESSURE SEAL FITTING INSTALLATION REQUIREMENTS

- A. Viega, ProPress Pressure Seal bronze or copper fittings: Sealing element shall be verified for the intended use. Tube ends shall be cut on a right angle (square) to the tube. Tube ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting. Utilizing a Viega Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the tube fully into the fitting and mark the tube wall at the face of the fitting. Always examine the tube to ensure it is fully inserted into the fitting prior to pressing the joint. ProPress fittings ½-inch thru 4-inch shall be installed according to the most current edition of the Viega installation guidelines, using appropriate sized rigid ProPress tools. Installers shall attend a Viega ProPress installation training class.
- B. After ProPress Pressure Seal fittings have been installed a “two step test” shall be followed. Pressurize the system with application appropriate test medium, water between 15 and 85 psi, or air/dry nitrogen between .5 and 45 psi. Check the pressure gauge for pressure loss. If the system does not hold pressure, walk the system and check for un-pressed fittings. Should you identify an un-pressed fitting ensure the tube is fully inserted into the fitting, and properly marked, prior to pressing the joint. After appropriate repairs have been made, retest the system per specification requirements, not to exceed 600 psi with water.

END OF SECTION

SECTION 230548 - VIBRATION CONTROLS FOR HVAC, PLUMBING AND FIRE PROTECTION EQUIPMENT

PART 1. RELATED DOCUMENTS

1.1. GENERAL

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to work of this section.
- B. All work under this section shall also be subject to the requirements of Division 23 Section, Common Work Results for HVAC.

1.2. SUMMARY

- A. Provide all labor and materials necessary to furnish and install vibration control systems on this project as herein specified and/or shown on the drawings.
- B. Mount all mechanical equipment on suitable vibration isolators so as to prevent transmission of vibration into or through the building structure. Isolators shall be as manufactured by Mason Industries, Inc., Korfund, Inc., Amber Booth, Vibration Mounting and Controls, or approved equal, and shall be selected by the isolator manufacturer for each item of equipment in accordance with requirements hereinafter specified.
- C. The equipment manufacturer shall supply all pump and motor bases, fan and motor bases, cradles, isolation pipe/duct hangers, spring and/or neoprene isolators, neoprene pads, flexible connectors, etc. as a coordinated package by a single manufacturer.
- D. Select isolators for uniform static deflections according to distribution of weight; and for not less than the indicated isolation efficiency with the lowest rotational speed of equipment as the disturbing frequency.
- E. Isolators and bases shall be stable during stopping and starting of equipment without transverse or eccentric movement of equipment, and shall be designed to resist horizontal forces of equipment which may operate unbalanced.
- F. In general, select isolators on the basis of criteria as specified in the ASHRAE Applications Handbook, Latest Edition.

1.3. SUBMITTALS

- A. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
- B. Product Data: Provide schedule of vibration isolator type with location and load on each.
- C. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- D. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.4. PROJECT RECORD DOCUMENTS

- A. Record actual locations of hangers including attachment points.

1.5. COLOR CODING

- A. All springs shall be color coded for load carrying capacity.

1.6. ALTERNATES

- A. Refer to Division 01 Section, Alternates - Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. MANUFACTURER

- A. Isolators shall be the equivalent of the following types by Mason Industries, Inc., Korfund, Inc. or approved equal.

2.2. CORROSION PROTECTION FOR STEEL PARTS

- A. Where steel parts are exposed to weather or humid environments provide hot-dipped galvanized coating of at least 2 ounces of zinc per square foot of surface. Coat springs with neoprene.

2.3. SPRING MOUNTS AND SOUND PADS

- A. Provide all spring mounts with leveling devices, minimum .25 inch thick neoprene sound pads, and zinc chromate plated hardware.
- B. All sound pads shall be size for minimum deflection of .05 inch; meet requirements for neoprene pad isolators.

2.4. SPRINGS

- A. All springs shall have minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between .3 and .6 of maximum deflection.

2.5. NEOPRENE

- A. Grade durometer 40, 50 OR 60 AND OIL RESISTANT.

2.6. FLOOR MOUNTED ISOLATORS:

- A. Neoprene Isolation Pads: Provide pads at least ¼ " thick with cross-ribbed or waffle design. For concentrated loads provide steel bearing plates bonded or cold cemented to the pads. Neoprene isolation pads shall be Type Super W.
- B. Neoprene Isolators: Rubber (neoprene)-in-shear mounting: Provide molded neoprene isolators having steel base plates with mounting holes and, at the top, steel mounting plates with mounting holes or threaded inserts. Provide elements of type and size coded with

molded letters or color-coded for capacity identification. Embed metal parts completely in neoprene. Double deflection neoprene mountings shall have a minimum static deflection of 0.35". Bolt holes shall be provided for these areas where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mounting to compensate for the over-hang. Mountings shall be type ND or rails type DNR.

2.7. SPRING ISOLATORS

- A. General: Provide spring isolators or protected spring isolators that are adjustable and laterally stable with free-standing springs of horizontal stiffness at minimum 80 percent of the vertical (axial) stiffness. For machine-attached and floor-attached restraining elements, separate from metal-to-metal contact by neoprene cushions 1/8 inch thick minimum. Provide neoprene acoustic friction pads at least ¼ inch thick.
- B. Spring Isolator: Spring type isolators shall be free standing and laterally stable without any housing and complete with ¼ " neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflections, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc. or as approved equal.

2.8. SUSPENSION ISOLATORS

- A. General: Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.
- B. Suspension Neoprene Isolators: Provide double-deflection elements with minimum 3/8 inch deflection.
- C. Suspension Spring Isolators: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30o arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30o capability. Hangers shall be type 30N.
- D. Precompressed Suspension Spring Isolators: Vibration hangers shall be as described in "C" above, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a scale drawing of the hanger showing the 30o capability. Hangers shall be type PC30N.
- E. Ductwork Suspension Spring Isolators: Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole

sizes shall be large enough to permit the hanger rod to swing thru a 30o arc before contacting the hole and short circuiting the spring. Spring shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30o capability. Hangers shall be type W30.

2.9. THRUST RESTRAINTS

- A. Adjustable spring thrust restraints, able to resist the thrust force with at least 25 percent unused capacity. The operating spring deflection shall be not less than 50 percent of the static deflection of the isolation supporting the machinery. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with one rod and angle bracket for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. Horizontal thrust restraints shall be type WB.

2.10. INERTIA BASES

- A. Structural Bases: Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch- bases shall be type WF.
- B. Structural Rails: Vibration isolator manufacturer shall provide steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment. Inverted saddles shall be type ICS.
- C. Concrete Bases: Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of half inch bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions. Forms shall be furnished with steel members to hold anchor-bolt sleeves when the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Concrete shall be 3,000 psi concrete. Mass of concrete inertia bases shall be minimum of 2 times weight of isolated equipment. Bases shall be type K.

2.11. FLEXIBLE CONNECTORS FOR PIPING

- A. General: Straight or elbow flexible connectors rated for temperatures, pressures, and fluids to be conveyed. Provide flexible connectors with the strength 4 times operating pressure at highest system operating temperature. Provide elbow flexible connectors with a permanently set angle.
- B. Elastomeric Flexible Connectors: Flexible neoprene connectors shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Connectors up to and including 1 ½ " diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Hoses shall be installed on the equipment side of the shut-off valves. Connectors shall be rated a minimum of 150 psi at 220oF. Flanged equipment shall be directly connected to neoprene elbows in the size range 2 ½ " through 12" if the piping makes a 90o turn at the equipment. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. 12" and larger sizes operating above 100 psi shall employ control cables with end fittings isolated by means of ½ " thick bridge bearing neoprene washer bushings designed for a maximum of 1000 psi.
- C. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies.
- D. Elbows shall be Mason-Flex type MFNEC, straight connectors Mason-Flex type MFTFU or MFTNC, and control cable assemblies type ACC.
- E. Metal Flexible Connectors: Fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Sizes 3" and larger shall be flanged. Sizes 2 ½ " and smaller shall have male nipples. Lengths shall be as indicated:

Nominal Diameter (Inches)	Length (Inches)
½ "	12"
¾"	12"
1 ½ "	12"
1 ½ "	12"
2"	12"
2 ½ "	12"
3"	18"

4"	18"
5"	24"
6"	24"
8"	24"
10"	24"
12"	36"
14"	36"
16"	36"

- F. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS.

2.12. NEOPRENE PAD ISOLATORS

- A. Rubber or neoprene waffle pads.
1. 30 durometer
 2. Minimum 2 inch (13mm) thick
 3. Maximum loading 40 psi (275 kPa)
 4. Height of ribs shall not exceed 0.7 times width.
- B. Configuration: ½ inch (13mm) thick waffle pads bonded each side of ¼ inch (6 mm) thick steel plate.

2.13. RUBBER MOUNTS

- A. Molded rubber designed for 0.6 inches (13 mm) deflection with threaded insert.

PART 3. EXECUTION

3.1. GENERAL PROVISIONS

- A. Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.
- B. Where neoprene elements of vibration isolator may be subjected to high pipe temperatures above 160°F, provide metal heat shields or thermal isolators.
- C. A minimum of 4" thick reinforced concrete housekeeping pads shall be provided under all floor mounted equipment. A minimum of 6" thick reinforced concrete housekeeping pads shall be provided under all boilers. Rest subbases on structural floor and reinforce with steel rods interconnected with floor reinforcing bars by tie bars hooked at both ends.

- Provide at least one (1) inch clearance between subbases and inertia bases, steel bases, and steel saddles with machinery in operation.
- D. All vibration isolators exposed to weather or humid environment shall be hot dipped galvanized with springs coated with neoprene in accordance with paragraph hereinbefore described.
 - E. Concrete inertia bases shall be a minimum of two (2) times the weight supported. Clearance between the underside of the inertia base and the housekeeping pad below shall not be less than 1 inch. Concrete shall be 3000 psi. Install inertia bases in accordance with the recommendations of the machinery manufacturer and the inertia base manufacturer.
 - F. Anchor Bolts and Grout: Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.
 - G. Common Machinery Foundations: Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.
 - H. Vertical Stops: For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.
 - I. Thrust Restraints: Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.
 - J. Machinery: Provide vibration isolators, flexible connectors and seismic snubbers in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.
 - K. Stability: Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.
 - L. Lateral Motion: The installed vibration isolation systems for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than ¼ -inch. Restrain motions in excess by approved spring mountings.
 - M. Unbalanced Machinery: Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.
 - N. Nonrotating Machinery: Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports

for the pipe connected to.

- O. Roof and Upper Floor Mounted Machinery: On the roof or upper floors, mount machinery on isolators with vertical stops. Rest isolators on beams or structures designed and installed in accordance with the SMACNA ASMM Plate 61.
 - P. Vibration isolation ceiling hangers shall be installed so that the hanger rods do not touch the sides of the isolator housing, thereby seriously degrading the vibration isolation performance. Vibration isolation ceiling hangers shall be located so that the hanger housing may rotate 360o without touching any object.
 - Q. Electrical Connections: Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2 inch minimum displacement in any direction without damage.
 - R. Systems Not To Be Vibration Isolated: Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.
 - S. Install in accordance with manufacturer's instructions.
 - T. Install isolation for motor driven equipment.
 - U. Bases:
 - 1. Set steel bases for one inch (25mm) clearance between housekeeping pad and base.
 - 2. Set concrete inertia bases for 2 inch (50mm) clearance between housekeeping pad and base.
 - 3. Adjust equipment level.
 - V. Install spring hangers without binding.
 - W. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
 - X. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
 - Y. Connect wiring to isolated equipment with flexible hanging loop.
- 3.2. MEDIUM AND HIGH PRESSURE DUCTWORK ISOLATION (4 INCH WATER COLUMN AND ABOVE)
- A. Provide vibration isolation for medium and high pressure ductwork operating with over four (4) inches water column. The isolator deflections shall be equal to or greater than the static deflection of the vibration isolators provided for the connected machinery as follows:

All discharge runs for a distance of 50' from the connection equipment (fans, exhausters

and blowers) shall be isolated from the building structure. Spring deflections shall be a minimum of 0.75".

- B. Ductwork Hanger and Support Installation: Provide ductwork with vibration isolation hangers and supports where located in mechanical equipment rooms. Connect ductwork to equipment with flexible duct connectors. Segment ductwork with flexible duct connectors.
- C. Duct Risers: Provide duct riser supports within shafts with suitable bearing plates and two layers of ¼ " thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with ¼ " steel plate.
- D. Supports at Base of Duct Risers: For duct isolation supports at the base of risers, provide two layers of ¼ " thick heavy-duty neoprene pad separated by ¼ " thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the duct and isolation support to the pipe, and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support ducts, provide a maximum deflection of ¼ " at the midspan of this steel under the supported load. Rigidly support duct from the supplementary steel and the supplementary steel isolators.
- E. Duct Anchors: Attach each end of the duct anchor to an omni-directional isolator which in turn shall be rigidly fastened to the steel framing or structural concrete as indicated. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.3. PIPE ISOLATION

A. Horizontal Pipe Isolation:

1. Precompressed Suspension Spring Isolators:

- a. For the first three pipe hangers in the main lines near the mechanical equipment provide precompressed suspension spring isolators. Floor supported piping shall rest on trained spring isolators. All precompressed suspension spring isolators hangers or the first three trained spring isolators mounts as noted above, will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6" and 2.5" deflection thereafter. All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.

2. Combination Spring and Neoprene Suspension Hanger:

- a. For horizontal runs in other than those hereinbefore specified provide suspension spring hangers (combination spring and neoprene) with .75" minimum steel spring deflection.
- b. Hot Water Supply/Return Piping:

- i. For the first 20 feet of the branch connection of the main supply and return piping at each floor.
 - ii. For all piping over 2" diameter.
- B. Floor-Supported Piping:
 1. Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators as described hereinbefore and selected to the guidelines of hangers.
 2. The first three adjacent floor supports shall be the restrained spring type with a blocking feature that prevents load transfer to equipment flanges as the piping is filled and drained.
 3. Where piping is subject to larger thermal movement a slide plate shall be installed on the top of the isolator. Slide plate shall be teflon, graphite or steel.
 4. Provide a thermal barrier where neoprene products are installed directly beneath steam or hot water lines.
- C. Pipe Risers: Provide pipe riser supports with bearing plates and two layers of ¼ " thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with ¼ " steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.
- D. Supports at Base of Pipe Risers: Piping isolation supports at the base of risers shall be two layers of ½" thick heavy-duty neoprene pad separated by ¼ " thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.
- E. Pipe Anchors: Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum ½ " thick pad of heavy-duty neoprene or heavy-duty neoprene and canvas. Provide vertical restraints by similar material to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.4. FLEXIBLE PIPE CONNECTORS

- A. Provide flexible connectors in accordance with manufacturers instructions where piping systems serving vibration isolated equipment and as shown on the drawings. Flexible connectors shall be installed near the connection to the equipment. Where liquid pulsation dampening is required, flexible connectors with spherical configuration may be used. Provide restraints for pipe connectors at pumps to prevent connector failure upon pump start-up.

- B. Provide flexible connectors at connections of air compressors to piping systems.

3.5. ISOLATION FOR SPECIFIC EQUIPMENT

- A. The vibration isolator manufacture shall provide isolators for all pieces of equipment provided for the job. Isolator shall be selected by the isolator manufacturer on the basis of criteria as specified in the ASHRAE Applications Handbook, latest edition, unless a more stringent requirement is indicated on the drawings.
- B. Pumps/Air Compressors:
 - 1. All base mounted pumps and air compressors shall be mounted on concrete inertia blocks supported on stable steel springs in series with ribbed neoprene pads selected for not less than 1.5 inch static deflection under full operating load. Mason Industries type SLF or as approved equal.
 - 2. Floor support of the initial pipe elbows at the pump discharge and suction diffuser at the pump intake shall be made from the isolated inertia base, not from the equipment room floor. Mason Industries Type K or as approved equal.
 - 3. Provide flexible pipe connections at pump suction and discharge. Mason Industries Type BSS or MFTNC/MFTFU with control rods type ACC or as approved equal.
 - 4. Provide discharge and suction vibration isolaters at all vertical in-line pumps.
- C. Air Handling Units /Heating Ventilating Units/Make-up Air Units/Energy Recovery Ventilators:
 - 1. All air handling units, H & V units, make-up air units, energy recovery ventilators, units shall be supported on stable steel springs in series with ribbed neoprene pads selected for not less than 1.5" deflection under full operating load. Mason Industries type SLF springs or as approved equal. Following the manufacturer's specific installation instructions for specific equipment is acceptable.
- D. Fans:
 - 1. Fans up to 22" wheel diameter shall be mounted stable steel springs in series with ribbed neoprene pads selected for not less than 1.5" static deflection (Mason Industries Type SLF or equivalent).
 - 2. Fans with wheel diameters 24" and greater shall be mounted on unhoused stable steel springs in series with ribbed neoprene pads and structural rails selected for not less than 2.5" static deflection (Mason Industries Type SLF or equivalent and structural rails Type ICS with thrust restraint provisions) and rails shall be Type ICS.
 - 3. All fans suspended from the ceiling, joists or roof structure, including outside air fans, return fans, relief air, ventilation fans, and exhaust fans, shall be suspended using hangers incorporating steel springs in series with neoprene, selected for not less than 3.5" static deflection under full load (Mason Industries Type 30N or

equivalent).

- E. Condensing Units: All condensing units shall be supported on stable steel springs in series with ribbed neoprene pads and structural rails selected for not less than 1" deflection under full operating load. All exterior isolators for condensing units shall be hot dipped galvanized including all hardware. Mason Industries Type SLF springs or as approved equal. Provide neoprene coated springs.
- F. All horizontal, vertical, and recessed unit heaters shall be suspended using hangers incorporating steel springs in series with neoprene selected for not less than 1" static deflection under full load (Mason Industries Type 30N or equivalent).
- G. Ductless Units: Indoor ductless units shall be supported with rubber grommet type suspension isolators. Outdoor ductless units or water cooled ductless units shall be supported on ribbed neoprene pads resting on roof curbs (roof application) or concrete pad.

3.6. MANUFACTURER'S FIELD SERVICES

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC AND PLUMBING

PART 1. GENERAL

1.1. GENERAL

- A. This section covers performance testing, adjusting and balancing of heating, ventilating, air conditioning and domestic re-circulating systems as specified in Division 23 Section, Heating, Ventilating, and Air Conditioning Equipment and in Division 22 Section, Plumbing Fixtures and Plumbing Equipment.
- B. For Common Work Results of HVAC, See Division 23. See Division 01 for General Requirements.
- C. The mechanical contractor shall select and employ an impartial, independent balancing agency to provide testing and balancing services for the heating, ventilating and air conditioning (HVAC) systems and other specified systems of this project.
- D. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC and plumbing systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.
- E. The items requiring testing, adjusting, and balancing include, but are not limited to, the following:

Air Systems:

- 1. Air Flow Monitoring Stations
- 2. Coils (Air Temperatures & Static Pressure Drops)
- 3. Diffusers, Registers and Grilles
- 4. Ductless Split System Units (Indoors and Outdoor Cooled Air Units)
- 5. Energy Recovery Ventilators
- 6. Exhaust Fans
- 7. Hot Gas Re-heat Coils
- 8. Heat Recovery Systems
- 9. H & V Units
- 10. Make-up Air Units
- 11. Relief Fans
- 12. Room Pressure Differentials

13. Supply Fan AHU
14. Unit Heaters
15. Variable Refrigerant Volume Systems
16. Ventilation Fans
17. Zone Branch and Main Ducts

Hydronic Systems:

1. Autoflow valves
2. Boilers
3. Coils
4. Condensate Pumps
5. Condensate overflow safety switches
6. Differential Pressure Bypass Valves
7. Domestic Hot Water Heater Pumps
8. Domestic Re-circulating Systems and Water Heater
9. Emergency Fixture Mixing Valves
10. Energy Recovery Ventilators
11. Flow Measuring Stations
12. Flow Meter Fittings
13. Heating and Ventilating Units
14. In-line Pumps
15. Make-up Air Units/Outside Air Units
16. Pumps
17. System Mains and Branches
18. Thermostatic Mixing Valves
19. Unit Heaters

1.2. EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire dampers, smoke dampers, and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.

1.3. QUALIFICATIONS OF THE BALANCE AGENCY

- A. The balancing agency shall be a member of the Associated Air Balance Council (AABC).
- B. The certified test and balance engineer shall be responsible for supervision and certification for the total work herein specified.
- C. All final reports shall be signed by the certified test and balance engineer.

1.4. PRE-BALANCING CONFERENCE

- A. Convene a conference one week prior to commencing work of this Section with all appropriate individuals.

1.5. STANDARDS

- A. The balancing agency shall perform the services specified herein in accordance with the Associated Air Balance Council's National Standards, including revisions, to the date of the contract.
- B. All terms in this specification shall have their meaning defined as stated in the National Standards.
- C. ADC: Test Code for grilles, registers, and diffusers.
- D. ASHRAE III: Practice for measurement, testing, adjusting and balancing of building heating, ventilation, air conditioning, and refrigeration systems.
- E. NEBB: Procedure standards for testing, adjusting, and balancing of environmental systems.
- F. SMACNA: HVAC systems testing, adjusting, and balancing.
- G. AABC: Associated Air Balance Council

1.6. COORDINATION

- A. It will be necessary for the balancing agency to perform its services in close coordination with the mechanical contractor.
- B. The plans and specifications have indicated meters, valves, dampers, and other devices for the purpose of adjusting the system to obtain optimum operating conditions. It will be the responsibility of the mechanical contractor to install these devices in a manner that will leave them accessible and readily adjustable. The balancing agency shall provide guidance if there is a questionable arrangement of a control or balancing device.
- C. The general contractor, mechanical contractor, temperature control contractor and suppliers of the HVAC equipment shall all cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components.
- D. For heat pumps, the manufacturer's start-up agency and Test and Balance Engineer shall assist each other with obtaining proper flow rates and refrigerant pressures.

1.7. INSTALLATION TOLERANCE

- A. Unless otherwise indicated, all air devices shall be adjusted to within plus or minus 10 percent of design. All fans shall be adjusted to within plus or minus 5 percent of design. All pumps and Hydronic equipment shall be adjusted to within plus or minus 5 percent of design.

1.8. RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

- A. The mechanical contractor shall sufficiently complete the installation and start all HVAC systems to insure they are working properly and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC system.

- B. Record equipment manufacturer's standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence on any equipment until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

- C. Air Distribution Systems
 - 1. Verify installation for conformity to design.
 - 2. Terminate all supply, return, outside air, exhaust air, relief air, ventilation air ducts, and pressure test them for leakage. Test pressure and leakage rate shall be as specified in Division 23 Section, HVAC Air Distribution System under Leakage Tests. Pressure testing shall be performed by mechanical contractor and witnessed by Test and Balance Engineer.
 - 3. Ensure that all volume dampers, fire dampers, and smoke damper are properly located and functional. Dampers serving requirements of minimum and maximum outside - return - relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
 - 4. Verify that all supply - return - exhaust and transfer grilles; registers, and diffusers are installed and operational.
 - 5. Ensure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.
 - 6. Ensure that all fans are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating. Record thermal overload ratings for all motors in the Test and Balance Report.
 - 7. Make any necessary changes to the sheaves, belts, and dampers, as required by the balancing agency, at no additional cost to the owner.
 - 8. Install clean filters.
 - 9. For heat pumps, provide refrigerant suction and discharge pressure to Test and Balance Engineer for inclusion in the final TAB Report.

- D. Water Circulating Systems
 - 1. Verify installation for conformity to design.
 - 2. Check all pumps to verify pump alignment and rotation.
 - 3. Ensure that systems are clean, with the proper strainer screens installed for normal operation.
 - 4. Check all pump motors for current and voltage, to ensure that motors do not exceed

nameplate rating.

5. Provide thermal overload protection of proper size and rating. Record thermal overload ratings for all motors. Insert data in Test and Balance Report.
6. Ensure that all water circulating systems shall be full and free of air; that expansion tanks are set for proper water level; and that all air vents were installed at high points of systems and are operating.

1.9. RESPONSIBILITIES OF THE TEMPERATURE CONTROL CONTRACTOR

- A. The temperature control contractor shall complete the installation of the temperature control system, and operate and test all control systems to ensure they are functioning properly as designed. The temperature control contractor shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter.
 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, freeze stats and duct smoke detectors.
 2. Verify that all controlling instruments are calibrated and set for design operating conditions.
 3. Calibrate temperature sensors after installation, and before the temperature sensors control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditional space for each separately controlled zone.
 4. The temperature control contractor shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.
- B. All control sequences, software, equipment, and components shall be started-up by a qualified technician. Start-up report shall be submitted to Engineer prior to the commencement of testing and balancing work. Testing and balancing shall not commence until start-up reports are completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

1.10. NOTIFICATION FOR TESTING AND BALANCING WORK TO BEGIN

- A. The mechanical contractor shall notify the balancing agency in writing when all heating, ventilating, and air conditioning systems are complete and ready for testing and balancing. The mechanical contractor shall attest that he has completed all items as herein described.
- B. The following must be completed prior to start of system balancing:
 1. All duct work and associated grilles/registers/diffusers installed and completed.
 2. Piping systems completed, flushed and filled.

3. Equipment properly started by qualified personnel or start-up technicians.
4. Ceiling tiles installed.
5. Automation system (temperature controls) installed and completed for both air and water systems.
6. All equipment controlled in automatic (“Auto”) mode.
7. Access granted to the balancing contractor to the automation/controls system provided.

1.11. DEFICIENCIES

- A. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.
- B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected Contractor before the TAB Agency returns to retest. Unresolved deficiencies shall be noted in the final report.

1.12. ADJUSTING

- A. Ensure recorded data represents actual measured observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring all sensors to specified settings.
- E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- F. Check and adjust systems approximately six months after final acceptance and submit report.
- G. Permanently mark the locations of all duct traverses on the exterior surface of the duct insulation.

1.13. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

1.14. GENERAL COMMISSIONING REQUIREMENTS

- A. Refer to Division 01 Section, “General Commissioning” for description of work under this Division affected by General Commissioning.

PART 2. PRODUCTS (NOT APPLICABLE)

PART 3. EXECUTION

3.1. GENERAL

- A. Perform all testing and balancing in complete accordance with AABC National Standards for Field Measurements and Instrumentation.
- B. Furnish all test instruments and equipment. All instruments must have been calibrated within twelve (12) months prior to use and shall be checked for accuracy prior to and during the work. Submit certificate for calibration of all equipment utilized on project with date of calibration clearly identified.
- C. Review all systems designs and equipment, manufacturers' data, and be completely familiar with the work before proceeding.
- D. Report all malfunctions or deficiencies to the contractor so that corrective action can be taken. Test and Balance Report shall not be submitted for review until all malfunctions or deficiencies are corrected. Repeat tests where required until design conditions are achieved.
- E. Where systems or equipment cannot be balanced or adjusted to design conditions, determine the cause and submit a complete report to the Engineer.
- F. Retest or rebalance the system as required during the warranty period.
- G. Test and balance all systems under adequate load condition. If, in the opinion of the Engineer, there is insufficient load to properly test and balance the systems, perform sufficient preliminary balancing and adjustment to permit operation of the systems until such time as final testing and balancing can be done. Provide in writing the future date when systems shall be tested under sufficient load.
- H. At project completion provide a complete set of 1/2 scale drawings indicating the locations of all duct traverses.

3.2. 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.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems – Duct Design". Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens and indicated perforations.
- 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 operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3. AIR SYSTEM PROCEDURES

- A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's National Standards:
 - 1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.
 - 2. Current and Voltage - Measure and record motor current and voltage. Check and record thermal overload ratings for all motors.
 - 3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply, return and

exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.

4. Outside Air - Test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.
5. Static Pressure - Test and record system static pressures, including suction and discharge static pressure of each fan. Record hood static pressure at automatic exhaust taps/exhaust taps, canopy hoods, and similar equipment. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make fan RPM allowances for 50 percent loading of filters.
6. Air Temperature - Take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil and/or heat recovery coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
7. Zone Ducts - Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
8. Main Ducts - Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.
9. Branch Ducts - Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
10. Magnahelic Gauges - Static pressure at static pressure tips for Magnahelic gauges shall be recorded in Test and Balance Reports.
11. Tolerances - Test and balance each diffuser, grille, and register to within 10 percent of design requirements. Test and balance all fans to within 5 percent of design requirements.
12. Identification - Identify the location and area of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.
13. Description - Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.
14. Minimizing Drafts - Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
15. Test and Balance Engineer shall witness and record all leakage testing of ductwork. Leakage test data shall be included in final Test and Balance Reports.
16. Where modulating dampers are provided, take measurements and balance at

extreme conditions. Balance variable air volume systems at maximum air flow rate, full cooling, and at minimum airflow rate, full heating.

17. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
18. For all equipment specified with condensate overflow safety switches/floats test operation of such device and record results. Verify interlock with ATC system.
19. Outside air and exhaust/relief air measurements must be measured and submitted in all modes of operation including the following:
 - a. Min Min Outside Air/Exhaust/Relief air mode (square footage outside air).
 - b. Min Max Outside Air/Exhaust/Relief air mode (square footage and people outside air).
 - c. Maximum outside air/exhaust/relief mode (full 100% economizer mode).
20. For all outside air modes of operation record and submit full static pressure profiles, amperage, BHP, air flow rates, external static pressure, and internal static pressure. Verify airflow rates with air flow monitoring stations and record results.

3.4. WATER SYSTEM PROCEDURES

- A. The various water circulating systems shall be filled, purged of air, and put into operation before hydronic balancing by the mechanical contractor.
- B. The flow of water through all coils shall be adjusted by manipulating balancing valves until the rated pressure drop through the coil or metering device is obtained. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- C. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC National Standards.
- D. All Hydronic equipment, domestic re-circulating pumps, and HVAC pumps shall be Tested and Balanced as described below:
 1. Water Treatment - Examine the water in the system and determine if the water has been treated and cleaned. If it has not, request the mechanical contractor to clean and treat the water prior to TAB work
 2. Strainers - Request that the mechanical contractor clean all strainers.
 3. Air Vents - Check all air vents at the high points of the water system and determine if they are installed and operating.
 4. Valves - Set all balancing valves to the full-open position for balancing.
 5. Pumps - Adjust all pumps and domestic hot water re-circulating water pumps to meet design GPM requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Measure and record operating current and voltage. Check and record thermal overloads installed on all pumps. Record in

Test and Balance Report.

6. Tolerances - Proceed to balance all coils, pumps, balance valves and boilers, to within 5 percent of design requirements.
7. Marking - Mark all settings and record all data after completing the flow readings and coil adjustments.
8. Where available pump capacity (due to diversity) is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
9. Test all A/C condensate pumps for proper operation.
10. Test condensate overflow safety switches.

E. Boilers:

1. Verify that boilers have been filled and started by others, and are in operation.
2. Current and Voltage - As applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Test and adjust water flow through water boilers.
4. Test and record temperature and pressure profiles of water boilers.

F. Coils:

1. Tolerances - Test, adjust, and balance all hydronic coils within 5 percent of design requirements.
2. Verification - Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

3.5. DOMESTIC HOT WATER RE-CIRCULATING SYSTEMS PROCEDURES

A. The domestic hot water re-circulating system shall be tested and balanced as indicated on the contract documents including:

1. Balance of circuit setters to design quantities indicated on contract documents.
2. Balance of re-circulating pumps to meet design GPM requirements.

B. Domestic Water Heaters/Generators:

1. Verify that all domestic water heaters have been filled and started by others and are in operation. Where heat pump water heaters are specified, test in electric only mode, heat pump mode, and simultaneous mode.
2. Test and record outlet temperature of water heater at approximate design recovery.

3. Current and Voltage: As applicable, test and record voltage and amperage, compare data with nameplate limits to ensure water heater elements or burners do not exceed nameplate data.
4. Test discharge temperature and flow rate at all lavatory/hand sink mixing valves. Also measure time period for fixtures to obtain hot water.

3.6. FIRE AND SMOKE TESTING PROCEDURES

- A. The TAB agency shall test fire damper to assure operation. It shall verify that an access door has been installed for each fire and smoke damper. For fire dampers, the TAB agency shall open the access door, disconnect the fusible link, and allow the damper to close. Operation should be smooth and the damper must close completely. The TAB agency shall then reset the damper. The damper must close quickly and completely. The TAB agency shall then reset the damper and observe its complete opening. Record results of tests within TAB report.

3.7. LIFE SAFETY CONTROLS TESTING PROCEDURES

- A. The TAB agency shall test and record life safety control operation on the HVAC equipment. It shall verify the installation of required smoke detectors in air handling equipment (AHE), and shall verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown. With the controls and alarm contractors, the TAB agency shall verify the operation of interconnected systems such as the AHU smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequences. Record results of tests within TAB report.

3.8. VERIFICATION OF TEMPERATURE CONTROL

- A. The balancing agency shall be assisted by the temperature control contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:
 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset.
 2. Verify that all controlling instruments are calibrated and set for design operating conditions.
 3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
 4. Test and calibrate all air flow monitoring stations for proper air flow.
 5. Test and calibrate all static pressure sensors for proper set point and control.
 6. Test and calibrate all differential pressure sensors. Record set point in Record and Information Books.

3.9. TEST AND BALANCE REPORTS

- A. The test and balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test and balance engineer.
- B. Six (6) copies of the test and balance report are required and shall be submitted to the Engineer. If, in the opinion of the Engineer, test results or portions thereof are incomplete or inconclusive, repeat necessary portions of the work to the satisfaction of the Engineer.
- C. The report shall contain the following general data in a format selected by the balancing agency:
 - 1. Project Number
 - 2. Contract Number
 - 3. Project Title
 - 4. Project Location
 - 5. Project Architect
 - 6. Project Mechanical Engineer
 - 7. Test & Balance Agency
 - 8. Test & Balance Engineer
 - 9. General Contractor
 - 10. Mechanical Subcontractor
 - 11. Dates tests were performed
 - 12. Certification
 - 13. Duct Leakage Tests
 - 14. Phone Numbers of all Individuals Listed Above
- D. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards.

3.10. TEST REPORT FORMS

- A. Air Moving Equipment and Fan Test Forms - Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling equipment test form:
 - 1. Manufacturer, model number, serial number, arrangement.
 - 2. All design and manufacturer-rated data.

3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
 4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, mixing boxes, and similar devices.
 5. Outside-air, return-air, and exhaust air total CFM.
 6. Actual operating current, voltage and brake horsepower of each fan motor. For packaged equipment, this includes supply fans, relief air fans, and condenser fans.
 7. Final RPM of each fan.
 8. Fan and motor sheave manufacturer, model, size, number of grooves, bore, and center distance.
 9. Belt size, quantity and make.
 10. Static-pressure controls final operating set points (if applicable).
 11. Total and external static pressure.
- B. Pump Test Forms - Submit pump curve showing design, operating, and no-flow points of operation. Also, record the following items on each pump test form:
1. Manufacturer, size, model, service and serial number.
 2. All design and manufacturer's rated data.
 3. Pump operating suction and discharge pressure and final total dynamic head.
 4. No flow (pump discharge valve closed) suction and discharge pressure and corresponding total dynamic head. This procedure is to determine actual impeller size. Record impeller size.
 5. Rated and actual operating current, voltage, and brake horsepower of each pump motor.
 6. Total operating head pressure.
 7. Shutoff, discharge and suction pressures.
 8. Shutoff, total head pressure.
- C. Boiler Test Forms - Record the following items on each chiller and boiler test form:
1. Manufacturer model number, serial numbers.
 2. All design and manufacturer's rated data.
 3. Service and location.

4. Actual pressure drop and related GPM primary side.
 5. Actual pressure drop and related GPM, secondary side.
 6. Primary side entering and leaving temperatures.
 7. Secondary side entering and leaving temperatures.
 8. Temperature control settings.
 9. Electrical characteristics.
- D. Heating and Cooling-Coil Test Forms - Record the following items on each test form:
1. Manufacturer, location, service.
 2. All design and manufacturer's rated data.
 3. Rated and actual water pressure drop through each coil and related GPM.
 4. Rated and actual static pressure drop across each coil.
 5. Rated and actual entering and leaving water temperatures across each coil.
 6. Wet-bulb and dry-bulb temperatures entering and leaving each cooling coil; dry-bulb temperatures entering and leaving each heating coil.
 7. Air flow (Design and Actual).
 8. For DX-coil, provide design and actual saturated suction temperature.
 9. For DX-Coil, provide design and actual discharge pressures.
- E. Air Monitoring Station Test Forms:
1. Identification /location.
 2. Manufacturer.
 3. Systems.
 4. Size and Model Number.
 5. Area.
 6. Design Velocity.
 7. Design Airflow.
 8. Test Velocity.
 9. Test Airflow.

10. Static Pressure Drop and Velocity Pressure.
 11. Station Calibrated Setting.
- F. Flow Measuring Station Test Forms:
1. Identification/location.
 2. Manufacturer.
 3. Size and Model Number.
 4. Design and Actual Flow Rate.
 5. Design and Actual Pressure Drop.
 6. ATC flow rate versus field measured flow rate.
- G. Electric Motors Test Forms: (Applies to all motors, including pumps, fans and HVAC equipment)
1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
 9. Thermal overload settings
- H. V-Belt Drive Test Forms:
1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.

- I. Duct Traverse Test Forms:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test airflow.
 - 8. Duct static pressure.
 - 9. Air temperature.
 - 10. Air correction factor.

- J. Duct Leakage Test Forms:
 - 1. Description of ductwork under test.
 - 2. Duct design operating pressure.
 - 3. Duct design test static pressure.
 - 4. Duct capacity, air flow.
 - 5. Maximum allowable leakage duct capacity times leak factor.
 - 6. Test apparatus.
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 - 7. Test static pressure.
 - 8. Test orifice differential pressure.
 - 9. Leakage.

- K. Air Distribution Test Sheet:
 - 1. Air terminal number.
 - 2. Room number/location.

3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design velocity.
 7. Design air flow.
 8. Test (final) velocity.
 9. Test (final) air flow.
 10. Percent of design air flow.
- L. Ductless Unit Test Forms:
1. Manufacturer
 2. Type, air conditioning, heat pump
 3. Identification number
 4. Location
 5. All design and manufacturer's rated data.
 6. Rated and actual entering and leaving dry bulb temperatures.
 7. Rated and actual entering and leaving wet bulb temperatures.
 8. Air flow (design and actual)
 9. Provide actual saturated suction temperature.
 10. Actual operating current, voltage and brake horsepower of each fan motor.
 11. Final fan RPM.
 12. For Air Cooled Variable Refrigerant Volume System test current, voltage, RPM, and breaker horsepower for outdoor unit.
 13. Verify minimum flow rate at each autoflow valve installed around control valves.
- M. Energy Recovery Ventilators Test Forms: Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling equipment test form:
1. Manufacturer, model number, serial number, arrangement.
 2. All design and manufacturer-rated data.

3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
 4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, energy wheels, and similar devices.
 5. Outside-air, and exhaust air total CFM.
 6. Actual operating current, voltage and brake horsepower of each fan motor.
 7. Final RPM of each fan.
 8. Fan and motor sheave manufacturer, model, size, number of grooves, bore, and center distance.
 9. Belt size, quantity and make.
 10. Total and external static pressure.
 11. Rated and actual static pressure drop across each energy wheel.
 12. Wet-bulb and dry-bulb temperatures entering and leaving each cooling coil, heat pipe and energy wheel. Dry-bulb temperatures entering and leaving each heating coil.
 13. For DX-coil, provide design and actual saturated suction temperature.
 14. Record carbon dioxide set points and actual readings for exhaust air stream at each ERV and global CO2 sensor.
 15. Entering and leaving air temperatures at hot gas re-heat coils.
 16. Record the supply fan and exhaust fan maximum hertz/speed and minimum hertz/speed. Provide measurements to ATC subcontractor for fan tracking control.
- N. Make-up Air Unit
1. Manufacturer model number, serial numbers.
 2. All design and manufacturer's rated data.
 3. Design and actual fluid pressure and related GPM.
 4. Electrical characteristics, design, and actual.
 5. Fan speed, static pressure voltage, amp draw.
 6. Bulb temperatures entering, leaving coil design, actual.
 7. Air flow rate/RPM at maximum flow and minimum flow.

8. Interlocked exhaust fan air flow rate/RPM at maximum flow and minimum flow.
 9. Temperatures entering and leaving the heat pipe, design, and actual.
 10. Record the supply fan and exhaust fan maximum hertz/speed and minimum hertz/speed. Provide measurements to ATC subcontractor for fan tracking control.
- O. Air Cooled Condensing Unit Test Forms:
1. Manufacturer
 2. Model Number
 3. Location
 4. Size/Capacity
 5. Fan RPM (Min and Max)
 6. Compressor and Condenser/Heat Pump Fan Electrical Characteristics
 7. Condenser/Heat Pump Fan RPM
 8. Amp Draw of all Components
 9. Refrigerant Suction/Discharge Pressures
 10. Thermal Overload Sizes
- P. Thermostatic Mixing Valve Test Forms
1. Manufacturer, Model Number, Series, Arrangement
 2. All manufacturer data.
 3. Verify all strainers are clean.
 4. Leaving temperature actual and design.
- Q. Water Heater Test Forms
1. Manufacturer, Model Number, Series
 2. All manufacturers' data.
 3. Verify all safeties.
 4. Record leaving water temperature actual and design.
 5. Verify operation in all modes of operation.
 6. Verify combustion air damper interlock.

7. Record electrical characteristics
- R. Condensate Over Flow Switches/Floats
1. Manufacturer
 2. Type
 3. Location
 4. Equipment shut down verification
 5. ATC interlock verification
- S. Heating and Ventilating Unit Test Forms: Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling equipment test form:
1. Manufacturer, model number, serial number, arrangement.
 2. All design and manufacturer-rated data.
 3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
 4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, energy wheels, and similar devices.
 5. Outside-air, and exhaust air total CFM.
 6. Actual operating current, voltage and brake horsepower of each fan motor.
 7. Final RPM of each fan.
 8. Fan and motor sheave manufacturer, model, size, number of grooves, bore, and center distance.
 9. Belt size, quantity and make.
 10. Total and external static pressure.
 11. Rated and actual static pressure drop across each energy wheel.
 12. Wet-bulb and dry-bulb temperatures entering and leaving energy wheel. Dry-bulb temperatures entering and leaving each heating coil.
 13. Test minimum air flow rate and maximum air flow rate. Submit amperage, air flow rates, RPM, hertz, and static pressure profile in all modes of operation.

END OF SECTION

SECTION 230600 – HEATING, VENTILATING, AND AIR CONDITIONING EQUIPMENT

PART 1. GENERAL

1.1. GENERAL

- A. The Conditions of the Contract and other General Requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, Common Work Results for HVAC and Division 01 Section General Requirements.

1.2. DESCRIPTION

- A. The work to be performed shall include all labor, materials and equipment necessary to furnish and install complete, all mechanical equipment as shown on drawings, hereinafter specified or reasonably implied, and leaving the same in satisfactory operation condition. It is the intent that systems be installed complete with all items necessary to accomplish this purpose.

1.3. SUBMITTALS

- A. Shop Drawings: Indicate assembly, equipment dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- B. Product Data:
 - 1. Provide literature which indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Provide data of filter media, filter performance data, filter assembly, and filters frames.
 - 3. Provide fan and pump curves with specified operating point clearly plotted.
 - 4. Submit sound power level data for both fan outlet and casing radiation at rated capacity. Submit sound power levels by octave band or sound pressure levels by octave band for all equipment.
 - 5. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 - 6. For carbon monoxide exhaust fans provide nozzle velocity of exhaust fan, total exhaust flow, and discharge plume height.

1.4. OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of General Requirements.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store all equipment in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- D. Comply with manufacturer's installation instructions for rigging, unloading and transporting equipment.
- E. Protect all motors, shafts, and bearings from weather and construction dust.

1.6. ENVIRONMENTAL REQUIREMENTS

- A. Do not operate any equipment for any purpose, temporary or permanent, until ductwork/piping is clean, filters/strainers are in place, bearings lubricated, and equipment has been test run under observation.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.8. EXTRA MATERIALS

- A. Provide one set of seals for each type and model of pump provided on the project.

PART 2. PRODUCTS

2.1. HEATING AND VENTILATING UNIT

- A. Provide and install H & V unit with integral energy recovery wheels as shown on contract drawings. H & V unit with integral energy recovery wheels shall be Daikin, York, Trane, or approved equal.
 - 1. Performance to be as scheduled on plans.
 - 2. Unit shall be of internal frame type construction of galvanized steel. All frame and panel shall be G90 galvanized steel. Where top panels are joined there shall be a standing seam to insure positive weather protection. All metal-to-metal surfaces shall be sealed, requiring no caulking at job site. Unit base to be designed for mounting on an interior concrete housekeeping pad.
 - 3. Unit casing to be insulated with minimum thermal resistance R-value of 13. Foam insulation shall have minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for minimum flash ignition temperature of 610 degrees Fahrenheit. Insulation in accordance with NFPA 90A and tested to meet UL 181 erosion requirements and secured to unit with water proof adhesive and

permanent mechanical fasteners.

4. All components shall be easily accessible through removable hinged doors for both exhaust fan, supply fan, filter, enthalpy wheel, heating coil, and damper compartments.
5. All piping within the unit enclosure shall be insulated with insulation type, thickness and jacketing as specified in Division 23 Section, "HVAC Insulation".

B. Fans

1. Fans shall be direct drive unhooded, backward curved plenum fans. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently sealed ball bearing pillow blocks. Bearings shall be selected for a minimum life in excess of 200,000 hours at maximum cataloged operating speeds. Blowers shall enable independent balancing of exhaust and supply airflow with adjustable sheaves for motors 10 horse power and below. Fans shall be located in draw-through position in referenced to the energy recovery wheel. Fan motors shall be premium efficiency. Furnish units with extended lube lines with grease plugs.
2. All internal electrical components shall be pre-wired for single point power connection. All electrical components shall be UL listed, approved or classified where applicable and wired in compliance with the National Electrical Code. The control center shall include a disconnect switch, motor starters, variable frequency drives, control circuit fusing, control transformer for 24 VAC circuit and motor starters. Motor starters shall consist of a contactor and Class 20 adjustable overload protection and shall be provided for all motors in the unit.
3. Housings shall be factory primed and painted in color as selected by Architect.
4. Return air stream and outside air stream shall be filtered prior to energy recovery unit. Furnish and install MERV-8 pleated filters, filter racks and access panels. Provide one (1) set of additional filter media to Owner for each unit.
5. Furnish and install filter housings with 2-inch thick filters on both air streams of the energy recovery wheel.
6. Unit shall include 2 inch thick, pleated panel outside air and return air filters with MERV rating of 8, upstream of the wheels.
7. Furnish outlet and inlet duct openings with flanged duct connections and field installed flexible duct connections.

C. Heating Water Heating Coil

1. Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
2. Coil shall be designed and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be

sine wave rippled.

3. Coil shall have half serpentine circuitry, 1 row and 12 fins per inch.
4. Coil shall have right hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
5. Control valves shall be field supplied and field installed.
6. Coils shall be located as indicated on Contract Documents.

D. Outside Air/Economizer

1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return sensible temperature activated fully modulating actuator.
2. Economizer shall be furnished with return air CO2 override.
3. During economizer mode the energy recovery wheel shall be bypassed.

E. Energy Recovery Section:

1. Unit shall contain a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
3. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
4. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

5. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
 6. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
 7. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty.
 8. Hinged service access door shall allow access to the wheel(s).
 9. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
 10. Energy recovery wheel rotation detection sensors shall be provided under Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems".
- F. Extra Materials:
1. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - a. Filters: Furnish one set of each type of filter.
 - b. Belts: Furnish one set of belts for each belt drive including energy recovery wheel in unit.
 - c. During flush out operation prior to opening, install a minimum MERV-8 filter in outside air and exhaust air filter housing.
- G. Demand Control Ventilation Components:
1. Unit shall be equipped with demand control ventilation capabilities that enable the varying of outdoor air and return air volumes based on building occupancy. A sensor shall be located in the spaces to monitor average CO2 levels of the occupied spaces. A variable frequency drive shall receive a 0-10 volt signal from the CO2 sensors and control the outdoor air volume to maintain a maximum of 1,000 ppm of CO2 in the occupied space. Supply air and return air fans shall be controlled simultaneously. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and return air volumes are always maintained. The variable frequency drive shall be factory mounted and wired.

CO2 sensors (space and outside air) shall be provided and interlocked by Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems".

2. Furnish each unit with the following:
 - a. Supply air fan variable frequency drive.
 - b. Return air fan variable frequency drive.
 - c. Space temperature sensor shall be provided under Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems"
 - d. Space humidity sensor shall be provided under Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems"
 - e. All controls necessary for economizer operation.
 - f. All motor operated dampers (outside air, relief air, economizer, and return).
 - g. Outside air flow monitoring station and exhaust air flow monitoring station shall be furnished and installed by the contractor in the ductwork.

H. Air Flow Monitoring Station (Field Installed in Ductwork)

1. Install air flow monitoring station in outside air duct and exhaust duct to control O.A. damper and exhaust fan speed to match outside air flow rate with exhaust air flow rate.

I. Air Controller

1. Controller shall be furnished and installed by the ATC subcontractor.
2. Controller
 - a. Field installed controller shall be capable of independent stand-alone operation and have the ability to communicate and integrate with widely-used building automation systems. Controller shall be IP addressable and be able to reside on a TCP/IP network. Controller shall have 2 RJ-45 Ethernet ports, 1 RS-232 port, and 1 RS-485 port. Coordinate with ATC subcontractor.
 - b. Controller shall require a PC with the configuration tool software for configuration and programming. Furnish with graphical user interface over IP option controller so the unit can be configured through a browser over the internet.
 - c. Controller shall have a full calendar schedule for occupied, unoccupied, and holiday scheduling.
 - d. Controller shall retain all programmed values in non-volatile memory in the event of a power failure.
 - e. Configuration tool software, when connected to unit controller, shall indicate unit status, set points, and faults.
 - f. All inputs and outputs on the controller shall be viewable via the interface.
 - g. All setpoints and schedules shall be editable via the interface by the Building Automation System.
 - h. In addition to standard inputs/outputs provide additional inputs/outputs as required to accomplish sequence of operation and items listed on point list.
 - i. The manufacturer shall be responsible for assisting and participating in the

integration of this equipment into the Building Automation System and shall provide programming, testing, verification and on site personnel as required.

J. Electrical

1. Unit shall be provided with standard power block for connecting power to the unit.
2. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on the voltage, the voltage is more than 10% under design voltage, or on phase reversal.
4. Unit shall be provided with manual reset low temperature limit controls which shut off the unit when the discharge temperature reaches a field adjustable setpoint.

K. Sequence of Operation

1. Refer to Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems" for sequences of operation.

2.2. DOUBLE WALL INDOOR CENTRAL STATION AIR HANDLING UNITS (CARBON MONOXIDE SYSTEM MAKEUP AIR UNIT)

A. Provide and install central station air handling units as shown and scheduled on the plans. The units shall be installed in a neat and workmanship like manner in strict accordance with specifications. Air handling units shall be Trane IAQ Modular Climate Changers, McQuay Vision, York AirPack, Carrier, Daikin, or approved equal. Provide components as detailed on the contract drawings.

B. General

1. Central station air handling units heating/ventilating units, and make-up air units shall be certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standards 430 for Central Station Air Handling units and 410 for coils.
2. Units shall be provided with nominal 1-inch deflection spring isolators, as required, or as recommended by the unit manufacturer.
3. The units shall be furnished complete with double wall insulated casings, centrifugal fans, coils as scheduled, insulated drain pan, motor, drive, belt guard, and accessories as required. Coils shall not exceed specified face velocities.
4. Adequate space around all sides of the air handling unit shall be provided for proper service and maintenance.
5. All units shall be horizontal draw through medium pressure units. Construct casing section located upstream of supply fan for operation at a minimum 4 inches w.g.

negative static pressure and downstream sections for operation at a minimum of 6 inches water gauge positive static pressure.

6. All units shall be factory primed and finished in colors as selected by Engineer.
7. Provide unit mounting legs to support all sections of unit and raise unit for proper trapping. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned, coated with rust inhibiting primer, and finished with rust inhibiting enamel. Contractor shall be responsible for all steel supports and hangers for hung units.
8. Fan discharge arrangements shall be coordinated with ductwork layout to minimize "system effect" per AMCA-Publication 201-90.
9. Provide 6-inch high unit mounting legs or base rail to support all sections of unit and raise unit for proper trapping. Unit mounting devices shall be galvanized steel and a minimum of 10 gauge. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned, coated with rust inhibiting primer, and finished with rust inhibiting enamel. Contractor shall be responsible for all steel supports and hangers for units.

C. Construction

1. Unit casing shall be constructed of minimum 18 gauge galvanized metal, formed and reinforced to provide a rigid assembly. Formed panels shall be removable to provide easy access to internal components. Each of the sectionalized modules and accessories shall be factory assembled. Removal of side panels shall not effect the structural integrity of the unit.
2. All exterior panels and structural frames shall be constructed of G90-U galvanized steel. Casings not constructed of G90-U galvanized steel, casings with welds on exterior surfaces, or casings with welds on interior surfaces that have burned through to exterior surfaces shall be chemically cleaned, coated with rust inhibiting primer, and finished with rust inhibiting enamel in order to prevent premature corrosion and microbial growth.
3. Seal and gasket all joints between exterior panels and structural frames with closed-cell foam gasketing for air seal and acoustical break.
4. Casing shall have full size removal access doors as shown on drawings. Access doors shall have 2-inch double wall construction. Provide automotive style neoprene gasketing around full perimeter of access doors to prevent air leakage. Provide "ventlock" style non-corrosive alloy latches operable from the inside or outside of unit. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement.
5. Insulate casing sections with 2-inch thick 1 ½ pound per cubic foot density fiber glass insulation or equivalent. Provide double wall casing construction and encase insulation between solid exterior and double wall interior casing panels such that no insulation is exposed to airstream. Foil facing on insulation is not acceptable as

alternate to double wall construction. Insulation shall comply with NFPA 90A.

6. Coils sections with two or more coils shall have a 4-inch spacer between each adjacent coil.
7. Fan sections with internally mounted motors shall be provided with a standard full size access door allowing easy access to the fan/motor assembly. Units with externally mounted motors shall be provided with an expanded metal belt guard with hole for tachometer.

D. Fans

1. Units shall be provided with double width double inlet, centrifugal-type wheels. Fans shall be Standard or Class II (as required by total static pressure) forward curved wheels or air foil type as scheduled. Every fan shall be rated in accordance with AMCA Standards and the fan section shall be certified in accordance with ARI Standard 430. Fan shafts shall be selected to operate well below the first critical speed and each shaft shall be factory coated after assembly with an anti-corrosion coating. After the pre-balanced fan is installed in the air handler the entire fan section shall be run to assure smooth and trouble-free operation.
2. Fan bearings shall be self-aligning, pillow block or flanged-type regreasable ball bearings and shall be supplied for an average life (L50) or 200,000 hours. All bearings shall be factory-lubricated and equipped with standard hydraulic grease fittings and extended lube lines. Provide dust caps on all hydraulic grease fittings.
3. Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with spring isolators. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A.
4. Fan section shall have full height, double wall, hinged, removable access doors for inspection and maintenance of internal components.
5. Weigh fan and motor assembly at AHU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM's as scheduled on drawings.
6. Fans with variable frequency drives shall be balanced for inverter duty operation.

E. Motors and Drives

1. Fan motors shall be externally mounted or as indicated on contract drawings. Air handling units with internal motors shall be provided with additional cooling capacity to compensate for motor heat added to airstream. Total cooling capacity, as schedule, shall be increased by 2500 btuh per motor horsepower for units with internally mounted motors.

2. Units shall be provided with the motor efficiencies as specified in Division 23 Section, Common Work Results for HVAC.
3. Motors shall be open NEMA Design B, rigid base, open drip proof, with Class B insulation.
4. Fan drives shall be selected for a 1.5 service factor and anti-static belts shall be furnished. One additional set of belts shall be provided for each air handling unit and delivered to the Owner's representative at the completion of the project.
5. Fan sections shall be equipped with double width double inlet, centrifugal type wheels.
6. Drives shall be variable pitch and suitable for adjustment within plus or minus 15 percent of specified RPM but not to exceed the maximum RPM of the unit.

F. Coils

1. Heating and pre-heat coils shall be furnished to meet the performance requirements set forth in the schedule. All coils shall have performance certified in accordance with ARI Standard 410. Coils shall be arranged in the unit for horizontal air flow and selected for a maximum face velocity as scheduled. Install coils such that headers and return bends are enclosed by unit casings. Low temperature coils (40 degrees F EPT) shall be properly circulated to prevent laminar flow at part load conditions.
2. Coil casing shall be constructed of heavy gauge galvanized metal with aluminum die-formed corrugated fins and guide channels to create turbulent wiping behind the tubes. The fins shall have drawn collars, be belled and mechanically expanded to firmly bound the cooper tubes to the fins. All coils shall be installed on tracks for easy removal from the air handling unit.
3. Drainable water coils shall be designed to operate at 250 psig design working pressure and up to 300 degrees F and shall be tested with 325 psig compressed air under water. Circuiting shall provide free draining and venting when installed, counter flow of air and water with water velocities not to exceed seven feet per second and without exceeding the water pressure drops scheduled. All coils must have same end connections regardless of the number of rows deep. Clearly label supply and return headers on outside of units such that direction of coil water flow is counter to direction of unit airflow.
4. Construct coils of configuration plate fins and seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
5. Construction coil casings of Galvanized G90-U Steel with formed end supports and top and bottom channels. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.
6. Coil grommets shall be provided on all coils to completely seal the area between

the coil connection and the unit casing.

G. Filters

1. Filters shall be nominal 2-inch standard size filters; [MERV8] pleated media type. Filters shall be Farr, medium efficiency pleated type 30/30 with welded wire media support grid.
2. Provide one additional set of filter media for each air handling unit to be delivered to the Owner's representative upon completion of the project.

H. Access Sections and Access Doors

1. Fully insulated, access sections shall be provided as indicated on the drawings. Sections provide a minimum of 18-inch accessible space with full-size access doors. Access for inspection and cleaning of the unit drain pan, coils, and fans sections shall be provided.
2. Access doors shall be provided in all sections as indicated on the drawings. Access doors shall be of double wall construction.
3. Panels shall be fully removable to allow for a proper way to thoroughly clean panels of microbial growth and to access internal parts.

I. Filter-Mixing Box

1. Provide factory fabricated filter mixing box section of the same construction and finish as unit casing. Filter sections shall have filter guides, and full height double wall, hinged, removable access door for filter removal. Provide filter blockoffs as required to prevent air bypass around filters. Filter-mixing box shall combine the filtering and mixing functions in one standard section. Angle filters shall be accessible from either side with hinged access doors.
2. Interconnected motor operated return air and outside air dampers shall be supplied by ATC contractor and installed by mechanical contractor in adjacent ductwork. Damper blades shall be parallel acting and shall rotate in nylon bearings providing smooth action and requiring no lubrication. Dampers shall be sectionalized to limit blade length, prevent warpage and assure a tight closure. Actuators shall be provided and installed by the ATC contractor.
3. Fixed position manual return air and outside air dampers shall be supplied with mixing boxes for manually directing air flow. Damper blades shall be parallel blade and shall rotate in nylon bearings providing smooth action and require no lubrication. Dampers shall be sectionalized to limit blade length, prevent warpage and assure a tight closure.
4. Provide field installed differential pressure gauge, two static pressure tips, vent valves, and red pointer flag, and air filter gauge accessory package to measure filter resistance. Accuracy shall be +/- 2 percent of full scale 0 to 1.0 inch w.g. range. Gauges shall be 2003 magnahelic by Dwyer Instruments or approved equal.

J. Installation

1. Install H & V units, and make-up air units where shown, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

K. The manufacturer shall in his selection, calculate and account for all heat produced within the air handling system casing. Heat sources which shall be accounted for are:

1. Heat produced by the inefficiency of the fan in converting energy input to static and velocity pressure.
2. Heat produced by the fan motor if located in the airstream.
3. Heat produced by the belts and sheaves, if located in the airstream.
4. Any other gains.
5. The manufacturer shall then modify the coil entering or leaving air temperatures such that when the heat gains act on the system, the specified performance is achieved.

L. Air Handling System Efficiency

1. Because it is important to the Owner to minimize the operating cost of equipment where applicable, the unit manufacturer's selected air handling unit shall not exceed the maximum cumulative break horsepower indicated on the plans.

M. Fan-Section Source Quality Control: the following factory tests are required.

1. Sound Power Level Ratings: 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.
2. 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.

2.3. AIR COOLED CONDENSING UNIT WITH HOT GAS RE-HEAT (ERV UNIT)

A. General

1. Furnish and install air cooled condensing units of the size, capacity, arrangement, and electrical characteristics as shown on the contract drawings. Condensing units shall be AAON Model CB-B, Trane, Innovent, Venmar, or approved equal.
2. System Description
 - a. Outdoor-mounted, air-cooled, split-system air conditioner unit suitable for ground installation. Unit consists of multiple scroll compressors, an air-

cooled coil, propeller-type condenser fan, and a control box. Unit shall discharge supply air upward as shown on contract drawings. Unit shall be used in a refrigeration circuit to match up to an indoor energy recovery ventilator unit.

3. Quality Assurance

- a. Unit shall be rated in accordance with the latest edition of ARI Standard 210 and 270. Unit shall be certified for capacity, efficiency, and sound and listed in the latest ARI directory. Unit construction shall comply with latest edition of ANSI/ASHRAE and with NEC. Unit shall be constructed in accordance with UL standards and shall carry the UL label of approval. Unit shall have c-UL approval. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test. Air-cooled condenser coils shall be leak tested at 150 psig and pressure tested at 300 psig. Unit constructed in ISO9002 approved facility.

4. Delivery, Storage, and Handling

- a. Unit shall be shipped as single package only and is stored and handled per unit manufacturer's recommendations.

5. Compressor shall be covered by a five year limited warranty. Complete unit shall be covered by a two-year limited parts warranty.

B. Products

1. Equipment

- a. Factory-assembled, single piece, air-cooled air conditioner unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge Puron, R410a, R407c, and special features required prior to field start-up.

2. Unit Cabinet

- a. Unit cabinet shall be constructed of galvanized steel, bonderized, and coated with a powder coat paint.

3. Fans

- a. Condenser fan shall be direct-drive propeller type, discharging air upward. Condenser fan motors shall be totally enclosed, 1-phase type with class B insulation and permanently lubricated bearings. Shafts shall be corrosion resistant. Fan blades shall be statically and dynamically balanced. Condenser fan openings shall be equipped with PVC-coated steel wire safety guards.

4. Compressor

- a. Compressor shall be protected by internal temperature and current sensitive overloads. Compressor shall include an internal pressure relief for high pressure protection. Furnish multiple compressors with lead compressor of the digital scroll type.
5. Condenser Coil
 - a. Condenser coil shall be air cooled. Coil shall be constructed of aluminum fins mechanically bonded to copper tubes which are then cleaned, dehydrated, and sealed.
 6. Refrigeration Components
 - a. Refrigeration circuit components shall include liquid line shut-off valve with sweat connections, suction shut-off valves with sweat connections, systems charge of refrigerant Puron, R410a, R407c, and compressor oil.
- C. Electrical Requirements
1. Nominal unit electrical characteristics shall be as scheduled on contract drawings. Unit electrical power shall be single point connection. Control circuit shall be 24v.
- D. Refrigeration System:
1. Air-Cooled Condenser Section:
 - a. The remote condensing section shall be equipped with vertical discharge axial flow direct drive fans. Direct drive fans shall be directly connected to and supported by the motor shaft.
 - b. Coils shall be designed for use with R-410A refrigerant.
 - c. Coils shall be helium leak tested.
 - d. The condenser coils shall be sloped at least 30° to protect the coils from damage.
 - e. Condenser coils shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - f. Condenser coil fin design shall be sine wave rippled.
 - g. Condenser coils to be sized for a minimum of 10°F of refrigerant sub-cooling.
 2. Remote split system compressors shall be scroll type with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators.
 3. Compressors shall carry a 5 year non pro-rated warranty.
 4. Unit shall include variable capacity scroll compressors on the lead (Quantity of 2) refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity. Furnish quantity of compressors as scheduled.
 5. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification

control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

6. Each refrigerant circuit shall be equipped with electronic thermostatic expansion valve type refrigerant flow control.
7. Each refrigerant circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant controls. Each refrigeration circuit shall be equipped with Schrader type service fittings on both the high pressure and low pressure sides.
8. Each refrigeration circuit shall be equipped with refrigerant liquid line driers.
9. Unit shall be fully factory charged with R-410A refrigerant.
10. Each compressor shall be equipped with suction and discharge service/isolation valves and tamper proof service caps.
11. Unit shall dehumidify using a hot gas reheat coil, modulating hot gas reheat control valves piped to the lead refrigerant system, and an electronic controller. A factory-wired, field installed, supply air temperature sensor and a field-installed space humidity sensor shall be provided to control the amount of reheat. The supply air temperature set point shall be adjusted on the electronic controller within the controls compartment.
12. All compressors shall be provided with a (5) five year parts and labor warranty.

E. Accessories

1. The following factory furnished accessories shall be provided with each condensing unit.
2. Cycle Protector
 - a. Solid-state timing device which prevents compressor rapid recycling. Control provides an approximate 5-minute delay after power to the compressor has been interrupted for any reason, including normal room thermostat cycling.
3. Winter Start Control
 - a. A SPST delay relay which bypasses the low-pressure switch for approximately 3 minutes to permit start-up for cooling operation under low-load conditions.
4. Evaporator Freeze Thermostat
 - a. A SPST temperature actuated switch which stops unit operation when evaporator reaches freeze-up conditions.
5. High-Pressure Switch

- a. Auto reset SPST switch activated by refrigerant pressure on high side of refrigerant circuit. Cycles, compressor off if refrigerant pressure rises to about 425 psig. Provides protection against compressor damage due to loss of outdoor airflow. To prevent rapid compressor recycling, cycle protector can be used with this switch.
6. Low-Pressure Switch
 - a. Auto reset SPST switch activated by refrigerant pressure on low side of refrigerant circuit. Cycles compressor off if refrigerant pressure drops to about 27 psig. Prevents indoor coil freeze-up due to loss of indoor airflow. Provides additional protection against compressor damage due to loss of refrigerant charge. To prevent rapid compressor recycling, cycle protector can be used with this switch.
7. Time-delay Relay
 - a. A SPST delay relay which briefly continues operation of the indoor blower motor to provide additional cooling after the compressor cycles off.
8. Crankcase Heater
 - a. An electric resistance heater which mounts to the base of the compressor to keep the lubricant warm during off cycles. Improves compressor lubrication on restart and minimizes chance of refrigerant slugging.
9. Low Ambient Controller
 - a. Allows operation of unit at low ambient (10 degrees F) conditions.
10. Mount unit on vibration isolators provided by manufacturer.
11. Wrap around sound attenuation cover for the compressor to reduce sound levels by 2 dBA minimum.
- F. Field Wiring
 1. Furnish and install all interconnecting control wiring between condenser, sensors and air handling unit to accomplish the specified sequence of operation. Furnish all required relays, wiring, and control transformers.
- G. Provide the services of a factory, authorized service representative to provide start-up and to demonstrate and train the Owner's maintenance personnel.
- H. Source Quality Control
 1. Verification of Performance: Rate condensing units according to ARI 210/240.
 2. Verification of Performance: Rate condensing unit according to ARI 340/360.
 3. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

4. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels, Division 1.
 - I. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.
- 2.4. DUCTLESS SPLIT SYSTEM AIR CONDITIONER (INVERTER TYPE) (WALL MOUNTED)
- A. The air conditioning system shall be a Mitsubishi Electric Series split type system, Sanyo, LG, Daikin, Samsung, or approved equal. The system to consist of a slim silhouette, compact wall mounted packaged evaporator section and matching Slim Line air cooled outdoor unit. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label. All wiring to be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 210 and bear the ARI label. A full charge of R-410A for 100 feet of refrigerant tubing shall be provided in the condensing unit. A dry nitrogen holding charge shall be provided in the evaporator. System SEER shall meet or exceed Federal Standards, latest edition.
 - B. The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of Mitsubishi Electronics America, Inc. This warranty does not include labor. Manufacturer shall have ten years experience in the U.S. market.
 - C. The unit performance shall be as scheduled on the contract drawings.
 - D. The indoor unit shall be completely factory assembled, and wired. The casing shall have a white finish. The evaporator fan shall be an assembly of line flow fans direct driven by a single motor. The fans shall be statically and dynamically balanced and run on a permanently lubricated bearing. An adjustable guide vane shall be provided with the ability to change the air flow from horizontal to vertical. A motorized air sweep louver shall provide an automatic change in air flow by directing the air from side to side for uniform air distribution. Return air shall be filtered by means of an easily removable washable filter. The evaporator coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coil shall be pressure tested at the factory. A condensate pan with drain shall be provided under the coil. Split system unit manufacturer shall furnish condensate lift pumps for field installation with the indoor unit. Condensate pumps shall be complete with float switch sensor, alarm, reed switch, relay, contact, adaptors and detection unit, etc., for a completely operational system. Contractor shall mount, pipe, and wire condensate pump per split system manufacturer's recommendations. Condensate pump shall be model EE as manufactured by Sauermann or approved equal.
 - E. The control system shall consist of two (2) microprocessors interconnected by a single non polar two wire cable as supplied. Wiring shall run from indoor unit to controller direct. NO SPLICES. When running longer lengths or more than one set of hardwired remote controller wires together, a double insulated, two wire cable equivalent to that provided e.g. Belden 9407 cable, is mandatory or use shielded two wire cable. One microprocessor shall be factory wired and located within the indoor unit. It shall have the capability of sensing return air temperature and indoor coil temperature; receive and process commands

from the hardwired remote controller; provide emergency operation; and control the outdoor unit. The microprocessor within the wall mounted hardwired remote controller shall provide automatic cooling; display set point and room temperature; a 24 hour on/off timer so that automatic operation can be set on the timer at one hour intervals from one to twenty four hours; have self diagnostic function display; check mode for memory of most recent problem; control operation of the air sweep louvers; and provide on off and system/mode function switching. Normal operation of the hardwired remote controller provides individual system control in which one hardwired remote controller and one indoor unit are installed in the same room. The hardwired remote controller shall have the capability of controlling up to a maximum of 50 systems at a maximum developed control cable distance of 1650 feet. Control voltage between the hardwired remote controller and the indoor unit shall be 12 volts, D.C. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, D.C. Both 12VDC shall be generated from the indoor unit microprocessor board. The system shall be capable of automatic restart when power is restored after power interruption. System shall include twenty function self diagnostics including total hours of compressor run time.

- F. The outdoor unit shall be completely factory assembled, piped and wired. The casing shall be fabricated of galvanized steel, bonderized and finished with baked enamel. The unit shall be furnished with one (1), direct drive, propeller type fan arranged for horizontal discharge. The motors shall have inherent protection be of the permanently lubricated type, and resiliently mounted for quiet operation. Each fan shall be provided with a raised guard to prevent contact with moving parts. The variable speed compressor shall be of the high performance, rotary type with crankcase heater, accumulator and internal thermal overloads. The variable speed compressor shall be mounted so as to avoid the transmission of vibration. The refrigeration system shall be equipped with high pressure switch and have the capability to operate with a maximum height difference of 130 feet and overall refrigerant tubing length of 130 feet between indoor and outdoor sections without the need for line size changes, traps or additional oil. Refrigerant flow from the condenser to be controlled by means of a capillary tube. The condenser coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The coil shall be protected with an integral metal guard. The unit shall be controlled by the microprocessor located in the matching indoor unit. A built in, low ambient controller will allow cooling to 0 degrees F outdoor temperature. The outdoor condensing unit shall be placed on vibration isolators and mounted on rooftop equipment rail or concrete pad as indicated on contract drawings.
- G. High condensate water safety shutdown: Each indoor unit's detection unit shall be interlocked to alarm and stop the outdoor unit if a high condensate water level is sensed.

2.5. FANS

A. General

1. Provide fans as indicated on the drawings. All fans shall have been tested and their performance rated in accordance with Air Movement and Control Association, Inc., Bulletin 210-85 Test Code and shall be licensed to bear the AMCA Seal. All fans shall carry the AMCA Certified Rating Seal for air and sound. Sound power levels shall be submitted for approval. Fan curves shall be submitted with all fan shop drawings.
2. Fan manufacturer shall submit under what duct configuration (unducted, partially

ducted, or ducted) the manufacturer certified the performance of a particular fan or group of fans.

3. When indicated on Contract Drawings provide inverter duty rated motors for all variable speed fans.
4. Any fan utilized to exhaust paint rooms, finishing rooms, carbon monoxide air, and similar spaces shall be sparkproof and shall include a phenolic coating on all components exposed to the airstream.

B. In-Line Mixed Flow Fans

1. Belt Drive

- a. Furnish and install in-line mixed flow belt drive fans of the size, capacity and electrical characteristics as shown on contract drawings.
- b. Duct mounted fans indicated shall be of the mixed flow belt driven in-line type. The fan housing shall be of the round design constructed of heavy gauge galvanized steel and shall include round duct mounting collars. Provide transitions from round to rectangular ductwork as indicated on Contract Drawings.
- c. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels shall be of sufficient size to permit easy access to all interior components. All in-line fans shall include a factory furnished sound vault housing. Housing shall include 2 inch acoustical insulation.
- d. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
- e. The wheel shall be of the mixed flow type. Wheels shall have a wheel cone, spherical back plate and single thickness cambered blades. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19. The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
- f. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified electrical characteristics. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance. Motors shall be high efficiency type.
- g. Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25 percent over the maximum operating speed for each pressure class. Close tolerances shall be maintained where the shaft makes contact with the bearing.
- h. Bearings shall be heavy duty, grease lubricated, self-aligning ball or roller flange mounted bearings with extended lubrication lines. Bearings shall be selected for a minimum life (L-50) of 200,000 hours at maximum, cataloged operating speed.
- i. Drives shall be sized for a minimum of 150 percent of driven horsepower.

Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

- j. Motor pulleys shall be adjustable for final system balancing.
- k. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.
- l. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
- m. Fans shall be Model QEI as manufactured by Greenheck Fan Corporation, ACME Engineering, Penn Ventilator, Cook or approved equal.

C. In-Line Centrifugal Fans

1. Belt Drive

- a. Furnish and install in-line centrifugal belt drive fans of the size, capacity and electrical characteristics as shown on contract drawings.
- b. Duct mounted fans shall be of the centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
- c. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components. All in-line fans shall be factory insulated. The housing interior shall be insulated with 1-inch acoustical insulation.
- d. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
- e. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance. Motors shall be high efficiency type.
- f. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed.
- g. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
- h. Motor pulleys shall be adjustable for final system balancing.
- i. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.
- j. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
- k. Fans shall be Model BSQ as manufactured by Greenheck Fan Corporation, ACME Engineering, Penn Ventilator, Cook, Twin City Fan and Blower or approved equal.

D. Sidewall Propeller Fans

1. Belt drive
 - a. Furnish and install belt driven propeller fans of size, capacity and electrical characteristics as shown on contract drawings.
 - b. All sidewall fans shall be belt driven axial type.
 - c. Propellers shall be constructed with die formed galvanized steel blades riveted to a steel hub. Propellers shall be statically and dynamically balanced.
 - d. Motors shall be of heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Two speed motors shall be furnished where indicated.
 - e. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Propellers shall be attached to fan shafts with a standard square key and set screws or tapered bushings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speeds. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor sheaves shall be adjustable for final system balancing.
 - f. Drive frame assemblies shall be formed galvanized steel construction. Fan panels shall have prepunched mounting holes, formed flanges with welded corners and a deep formed inlet venturi.
 - g. The axial exhaust or supply fans shall bear the AMCA Certified Ratings Seals for both air and sound performance.
 - h. All steel parts shall be protected with thermally fused polyester urethane. Fan shafts shall be coated with a zinc phosphate corrosion resistant coating.
 - i. Fans shall be provided with OSHA Safety Guard. Supply fans shall be of the reverse flow configuration. Provide wall mount collars, and 2-inch aluminum birdscreen with each fan as indicated on contract drawings. Motor operated dampers shall be provided by ATC subcontractor and installed by mechanical contractor.
 - j. Fans shall be Model SBE for exhaust and SBS for supply as manufactured by Greenheck, ACME Engineering, Penn Ventilator, Cook, Twin City Fan and Blower or approved equal.

2.6. HOT WATER CONDENSING BOILERS

A. General Description

1. Furnish and install as herein specified, shown or scheduled on the Contract Drawings, new Boiler/Burner units for water heating service and arranged for completely automatic operation firing on natural gas.
2. The boiler shall be a Lochinvar Knight XL Model KB(N)N, Viessman, AO Smith, or approved equal, having a modulating input rating and shall be operated on (Natural Gas). The boiler shall be capable of full modulation firing down to scheduled minimum input rating. The boiler shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. There shall be no banding material, bolts, gaskets, or "O" rings in the header configuration. The

316L stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

3. The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the BTS2000 Standard. The boiler shall be certified for indoor installation. The boiler's thermal efficiency shall be verified through third party testing by the Hydronics Institute Division of AHRI and listed in the AHRI Certification Directory.
4. Boiler/burner unit shall have been rated in accordance with Hydronics Institute Testing and Rating Standard for heating boilers, and shall be performance tested and listed by I.B.R. at +.10 inches water draft. The boiler, burner and installation shall meet all requirements of the State of Delaware Boiler Requirements, including ASME CSD-1, Amendments and Addenda, latest edition. The boiler and installation shall comply with all requirements of the local Boiler Inspector. Contractor must submit any deficiencies cited by the Boiler Inspector to the Engineer and Owner for review.
5. Boiler/burner unit(s) shall be as manufactured by Lockinvar, Viessmann, AO Smith, Raypack, or approved equal.

B. Boiler Construction/Installation

1. The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The boiler shall be supplied with a gas valved designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column. The boiler shall be equipped with leveling legs.
2. The boiler shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with; a temperature/pressure gauge, high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, return water temperature sensor, a UL353 certified flue temperature sensor, outdoor air sensor, low water flow protection and built-in adjustable freeze protection.
3. The boiler shall feature the "Smart System" control with a Multi-Colored Graphic

LCD display with Navigation Dial and Soft Keys for, password security, three loop temperature setpoints with individual outdoor air reset curves, pump delay with adjustable freeze protection, pump exercise, and USB PC port connection. The boiler shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or setpoint, enable/disable of the boiler, variable system pump signal and a 0-10 VDC output of boiler modulation rate. The boiler shall have a built-in "Cascade" with sequencing options for "lead lag" or "efficiency optimized" modulation logic, with both capable of rotation while maintaining modulation of up to eight boilers without utilization of an external controller. Supply voltage shall be as scheduled on the Contract Drawings.

4. The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 42 data points for safety and operating control, i.e., Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Three Wall Thermostat/Zone Controls, System Supply Sensor, Outdoor Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit. A high voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pumps, and the boiler pump.
 - a. The boiler shall be installed and vented with a direct vent system. The flue shall be CPVC sealed vent material terminating with the manufacturer's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe shall be PVC pipe. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet.
5. The boiler shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of 20 ppm or less corrected to 3% O₂. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
6. The boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
7. The boiler shall be suitable for use with polypropylene glycol, up to 50% concentration without contingencies.
8. The firing control system shall be Direct Spark Ignition with Electronic Supervision.
9. Optional Construction Codes:
 - a. The boiler shall be constructed in accordance with Delaware Pressure Vessel Code, ASME Boiler Code, include CSD-1 with all amendments.
10. All boiler discharges shall be piped to floor drains. Blowdown valves shall be

Brass, ball type and not less than one inch IPS and they shall discharge to a floor drain or away from the boiler as directed by the Engineer. Pipe ends shall be cut at a 45 Degree to prevent a cap or plug from being installed. All such discharge piping shall be supported by hangars or stand-offs to prevent the valve body from undue stress or strain. All boiler discharge piping shall be Type L copper piping.

11. Boiler drain valves shall be connected to the lowest water space available and shall be installed with pipe and fittings to connect the bottom blowoff full size to drain.
12. OS&Y stop valves shall be provided in the supply and return pipe connections to the boiler. Provisions shall be made for the expansion and contraction of the heating mains connected to the boiler by providing substantial anchorage at suitable points and assisted by the use of swing joints to allow the piping to expand and contract without imposing excessive forces on the boiler piping.

C. Water Trim

1. Install a new A.S.M.E. schedule pressure relief valve set for 50 PSI; 3 ½ -inch diameter pressure/altitude gauge; high limit temperature control with manual reset; operating temperature controls; and a Hydrolevel safeguard #550 low water cut-off. A factory furnished (unit mounted) thermometer and pressure gauge shall be provided with each boiler.

D. Flame Safeguard

1. Burner shall be furnished with an electronic flame safeguard control and flame detector. The control shall be a Fireye Micro M Flame Safeguard. Each type of flame safeguard shall be furnished with a UV scanner. Furnish with dry contacts for interlock with ATC system.

E. Gas Burners

1. Furnish and install FM/Underwriters Labeled gas burner. The burner design, construction, components and installation shall meet all applicable code requirements.
2. Each burner shall be capable of burning natural gas, with a specific gravity of 0.60. Gas pressure applied to the burner gas train supply connection shall be a minimum of 7 In. W.C.
3. The burner shall be listed by Underwriters Laboratories and shall bear the appropriate U.L. label (in addition to the U.L. requirements, all equipment and installation procedures shall meet the requirements of FM codes, CSD-1, and the local Boiler Inspector). The burner shall be designed and constructed as an integrated combustion system package and shall be factory fire tested.
4. The U.L. /F.M. gas valve train shall contain the following:
 - a. Manual Shutoff cock.
 - b. Main gas pressure regulator.
 - c. Automatically operated main motorized gas valve with proof of closure

- d. interlock switch.
 - e. Automatically operated auxiliary gas valve.
 - f. Manual reset Low and High Gas Pressure switches.
 - g. Manual leak test cock.
 - h. U.L. listed leak test cock.
 - h. Automatically operated main motorized gas valve with proof of closure shall carry a FM label.
5. All regulators and pressure relief valves shall be piped to the building exterior and terminated with a gooseneck and vermin screen as required in CSD-1.
 6. A safety manual reset type limit control shall be provided to shut the burner down in the event of excessive temperature.
 7. Modulation: Fully modulating as scheduled on the Contract Drawings.
 8. For FM Modulation. Purge operation of the modulating motor shall provide electrical interlock at 60 percent air flow position of the burner damper and electrical interlock at the damper low fire start position before the ignition sequence can begin.
 9. The burner electrical circuit shall contain a set of dry contacts for interlocking with ATC system if a flame failure, low water condition, or condensate blockage occurs. Coordinate requirements with ATC system.
 10. The flame safeguard control system shall include Ultraviolet sensor for flame detection and provide fully automatic sequencing of prepurge and postpurge, blower motor, interrupted ignition system, and fuel/air flow components. Flame safeguard shall provide safety shutdown with manual reset on air flow failure. The flame safeguard control shall be Fireye Micro M Flame Safeguard.
 11. The burner shall be complete with an integral burner mounted control panel which shall house all required operating electrical components. All wiring within the combustion system shall be factory prewired to a terminal strip mounted within the control panel.
 12. Appropriate electrical knockouts shall be provided on both sides of the panel to allow for necessary power and limit control wiring. The control panel shall be constructed of 16 gauge steel and shall be complete with a top switch and control section which shall be hinged to allow for full access to all panel mounted components. The control panel shall be painted in a color and finish identical to the burner being supplied.
 13. The control panel shall include a control circuit transformer fused on both the primary and secondary windings - flame safeguard control as specified above - on-off switch - motor starters, relays, terminal blocks indicating lights, service switches, and power switches, and other electrical devices as required.
- F. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Hydro level 550 Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
 5. Primary gas safety controls: Labeled and listed by nationally recognized testing agency. Manual re-set type that requires intervention by operator or service technician to re-set.
- G. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm low water level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 - c. Flame failure and low water condition alarms.
 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.
- H. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color-coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.
 4. Field power interface shall be to nonfused disconnect switch and circuit breaker.
 5. Provide each motor with overcurrent protection.
- I. Additional Requirements:
1. High limit control.
 2. Flow switch.

3. Burner mounting flange.
4. Inspection tappings (1 ½-inch, 3 per section).
5. Factory start-up including combustion analysis and, flue gas analysis report. (Submit to Engineer for approval - include in O&M Manual).
6. Furnish and install low water cut-offs that meet the requirements of A.S.M.E. Code CSD-1, latest edition. Low water cut-offs shall be probe type, Hydro Level Company Model 550 or approved equal. Low water cut-offs shall be fully testable with manual re-set. Manual re-set function shall not trip out due to power failures or bubbles. Provide low water cut-off with dry contacts for interfacing with ATC system. Install low water cut-off in a Model FOEM manifold fitting.
7. Control devices as required to perform sequence of operation including emergency shut-off switches, and central control and monitoring requirements.
8. Insurance certificate - Include in-shop drawings and O & M Manual.

2.7. BASE MOUNTED PUMPS - END SUCTION

- A. Furnish and install base mounted centrifugal end suction pumps to circulate hydronic water to the various items of equipment throughout the building, associated with the HVAC system. Pumps shall have sizes and capacities as indicated on the drawings.
- B. All pumps shall be suitable for the service and temperatures designated and shall conform to the following requirements. Each pump shall have a factory installed seal flushing line running from the seal area to the pump suction to insure removal of trapped air from the seal area, removal of sediment, and cooling of the seal to extend seal life. Provide and install Cuno five (5) micron filters in seal flushing lines. Provide two (2) sets of cartridges for each side - stream filter.
- C. Pumps shall be cast iron bronze fitted and shall be suitable for up to 175 psi working pressure and up to 250 degrees F water temperature. Pumps shall have center-line discharge for positive venting and flanged bodies. Pumps shall incorporate a grease lubrication system and be so designed that the bearing assembly can be removed in one piece. A water slinger shall be provided between the mechanical seal and bearing areas. Pump shafts shall be stainless steel with a cupro-nickel sleeve, and be coupled to the motor shaft by a noiseless, non-metallic coupler with guard. Impellers shall be one piece cast bronze, dynamically balanced. Motors shall be 1750 rpm. For variable speed pumps, motors shall be inverter duty rated.
- D. Pumps shall be designed so that they shall not overload at low heads and shall not develop excessive pressure under throttled flow conditions or overload motor anywhere on the operating curve. Operating performance curves shall be submitted for approval. Provide gauge tappings on each pump flange. Furnish dust caps at all oil fill tubes. Pump motors shall be non-overloading throughout the range of the curves.
- E. When pumps are operated in parallel, pumps must be selected so as not to “run-out” to the end of the pump curve. Submit pump curves for parallel pump operation and single pump operation.

- F. Units shall be provided with motors of not less than the horsepower indicated, suitable for the service and available electrical characteristics. Units shall be controlled as hereinafter specified. After installation and prior to operation, each pump shall be aligned. Motors shall be as specified hereinbefore.
- G. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- H. Impeller: Bronze, fully enclosed, keyed to shaft.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.
- J. Pumps shall be primed and painted in baked enamel, rust resistant paint.
- K. Electrical characteristics shall be as scheduled on the contract drawings. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA-70.
- L. Pumps shall be FE series as manufactured by Taco, 2000 Series by Allis Chalmers, Aurora, Bell & Gossett, PACO, Armstrong, Patterson, or as approved equal.

2.8. IN-LINE CIRCULATING PUMPS

- A. Furnish and install in-line circulating pumps as shown on the contract drawings. Pump and motor shall be equipped with sleeve bearings for quiet operation. Pumps shall be suitable for up to 175 psi working pressure and up to 300 degrees F water temperature as per ASA B16.1. Pump rating curves shall be the result of testing and rating in accordance with the procedures of the Hydraulic Institute.
- B. Pump motors shall be non-overloading throughout the range of the curves. Pumps shall have center-line discharge for positive venting, flanged bodies, and same size suction and discharge. Pumps shall incorporate a disc type lubrication system and be so designed that the bearing assembly can be removed in one piece. One bearing assembly shall be suitable for all sizes of the inline pumps furnished. Sump oil temperature may not exceed 180 degrees F when circulating 250 degrees F water with a 90 degree F ambient. Vent and drain openings at least 3 square inches in area and a water slinger shall be provided between the mechanical seal and bearing area. This water slinger shall be integral with shaft sleeve. All in-line circulating pumps shall be provided with all bronze construction when used in open system and shall be bronze fitted for closed system.
- C. Provide gauge tappings on each pump flange.
- D. Pump body shall be cast iron and pump shafts shall be alloy steel with cupro-nickel sleeve covering all wetted parts, and be coupled to the motor shaft by a noiseless non-metallic coupler. Impellers shall be one piece cast bronze, dynamically balanced. Pumps shall have a two piece mechanical seal assembly easily replaceable without the use of special tools. Motors shall be resilient mounted, 1750 RPM, and require no external overload protection when used with single phase current.
- E. Electrical characteristics shall be as scheduled on the contract drawings. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose

terminal lugs in terminal box sized to NFPA-70.

- F. In line pumps shall be Red Baron Series 110 in-line circulators or 1600 Series, as manufactured by Taco, Bell & Gossett, Thrush, Armstrong, Patterson, or as approved equal.

2.9. IN-LINE CLOSE COUPLED CIRCULATING PUMP

- A. Furnish and install in-line closed coupled circulating pumps as shown on the contract drawings. Pump and motor shall be equipped with permanently lubricated bearings for quiet operation. Pumps shall be suitable for up to 150 psi working pressure and up to 225 degrees F water temperature as per ASA B16.1. Pump rating curves shall be the result of testing and rating in accordance with the procedures of the Hydraulic Institute.
- B. The pumps shall be of the horizontal, permanently lubricated type, specifically designed and guaranteed for quiet operation.
- C. Provide gauge tappings on each pump flange.
- D. The pumps shall have a steel shaft supported by permanently lubricated, sealed precision ball bearings. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on silicon carbide. The motor shall be non-overloading at any point on the pump performance curve.
- E. The motor shall be of the drip-proof, sealed precision ball-bearing, quiet-operating construction. The permanent split-capacitor motor shall be equipped with thermal overload protection.
- F. Pumps to be suitable for 0 degrees to 225 degrees F (107 degrees C) operating temperature at 150 psig (10 bar) working pressure.
- G. Pumps shall be provided with all bronze construction when used in open systems and shall be bronze fitted for closed systems.
- H. Electrical characteristics shall be as scheduled on the contract drawings. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA-70.
- I. In line pumps shall be close coupled in-line circulators Model PL as manufactured by Bell & Gossett, Thrush, Armstrong, Taco, Patterson, or as approved equal.

2.10. VARIABLE SPEED DRIVES

- A. Provide variable speed drive controllers for Air Handling Units and associated Return Air Fans, Relief Air Fans, and Pumps as indicated on contract drawings.
- B. ERV variable speed drives shall be factory furnished by ERV unit manufacturer.
- C. The adjustable frequency controller (AFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power for stepless motor control from 5 percent to 110 percent of base speed.

- D. The AFC shall be a voltage source type with a PWM output utilizing power transistor semi-conductors.
- E. The AFC together with all options and modifications shall mount within a standard NEMA 1 enclosure suitable for continuous operation at ambient temperature of 0 to 40 degrees C. with relative humidity to 95 percent non-condensing. All high voltage components within enclosure shall be isolated with steel covers. The complete unit shall be UL approved and UL labeled.
- F. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. AFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:
 - 1. Motor overload.
 - 2. Shortcircuit.
 - 3. Motor overtemperature fault.
 - 4. Reverse phase.
 - 5. 110 percent of controller maximum sine wave current rating is exceeded.
 - 6. Output phase to phase and phase to ground short circuit condition.
 - 7. High input line voltage.
 - 8. Low input line voltage.
 - 9. Loss of input phase.
 - 10. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts such as high static, firestat, etc., to shut down the drive.
- G. The following adjustments shall be available in the controller and retained in non-volatile memory:
 - 1. Maximum frequency (15 to 400 Hz) factory set at 60 Hz.
 - 2. Minimum frequency (3 to 60 Hz) factory set at 6 Hz.
 - 3. Acceleration (.1 to 360 seconds) factory set at 20 seconds.
 - 4. Deceleration (.1 to 360 seconds) factory set at 20 seconds.
 - 5. Volts/Hertz ratio factory set for 460V at 60 Hz.
 - 6. Voltage offset or boost factory set at 100 percent torque.
 - 7. Current limit (50 percent to 110 percent sine wave current rating) factory set at 100 percent current.

- H. The AFC shall have the following basic features:
1. Door-mounted operators controls consisting of a membrane command center which allows manual stop/start and speed control, local/remote indication and manual/or automatic speed control selection. In addition, the command center shall serve as a means to configure controller parameters such as min speed, max speed, acceleration and deceleration times, Volts/Hz ratio, torque boost etc. Potentiometers shall not be allowed for these settings.
 2. Main input disconnect to provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.
 3. Electronic motor overload relay.
 4. Automatic restart after power outage, drive fault or external fault, with drive in automatic mode. The circuit shall allow the user to select up to (10) restart attempts as well as the dwell time between attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.
 5. Door-mounted LED display for digital indication of:
 - a. Frequency output
 - b. Voltage output
 - c. Current output
 - d. First fault indication
 - e. Fan or Pump Speed (RPM)
 6. Relay contacts for remote indication of drive fault and motor finning.
 7. Three critical frequency avoidance bands, field programmable via the membrane command center. Each critical frequency avoidance band shall have a bandwidth adjustable via keypad entry of up to 10 Hz.
 8. Three programmable preset speeds which shall force the AFC to a preset speed upon a user contract closure.
 9. Isolated process follower to enable VFC to follow a 4-20 mA signal.
 10. The AFC shall have the capability to ride through power dips up to 500 msec without a controller trip depending on load and operating condition.
 11. Line reactor to minimize line surges, line notching, and voltage distortions. Line reactor shall be installed upstream of the drive.
- I. Manual bypass-to-line with magnetic contactors to transfer motor from the variable frequency controller to full speed operation on utility supplied input power while the motor is at any speed. Two motor contactors, electrically interlocked shall be utilized, one contactor between the controller output and the motor and the other between the bypass

power line and the motor, providing across-the-line starting.

- J. Motor protection per National Electrical Code shall be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 115 volt A-C relay control logic, allowing common start/stop commands in the "controller" mode and the "bypass" mode shall also be included within the enclosure.
- K. The bypass shall include a door interlocked, main power input circuit breaker providing positive shutdown of all power to both the bypass circuitry and the VFC. The bypass circuit shall also include a second input disconnect to the VFC. This disconnect shall provide the ability to safely trouble shoot and test the controller, both energized and de-energized, while operating the bypass mode.
- L. The VFC and all components shall be supplied within a single NEMA 1 enclosure, and shall be U.L. Listed as a single unit. Furnish all components necessary to provide a minimum lead length between motor and drive of 400 ft. The VFC shall not generate damaging transistor pulses greater than the limits set by NEMA MG-1 at 400 Ft lead length.
- M. The VFC manufacturer shall maintain and staff nationwide service centers. These service engineers shall be employed by the manufacturer and provide start-up service including physical inspection of drive and connecting wiring and final adjustments to meet specified performance requirements.
- N. The VFC shall carry a full parts and labor warranty for two years from date of Owner acceptance of the building.
- O. The variable speed drive shall be ABB, or approved equal of Accutrol, Cutler Hammer, Graham, York, Baldor, AC Tech, Trane, Emerson, Danfos, Yaskawa, Toshiba, or as approved equal.
- P. The variable speed drive manufacturer shall coordinate with the ATC contractor and provide all necessary devices whether optional or not to perform complete and automatic operation as described in the sequence of operation. All safeties, including freezestats, duct smoke detectors, and high static pressure sensors shall be enabled when variable speed drives are in manual or bypass.
- Q. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
 - 1. Network Communications Ports: Ethernet and RS-422/485.
 - 2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.
- R. Variable speed drives shall be carefully selected for the duty required. Variable speed drives shall be specifically designed for the specified equipment to be controlled. Pump drives shall be selected for pumps and fan drives shall be selected for fans.

2.11. COMBINATION COALESCING AIR AND DIRT SEPARATOR

- A. Furnish and install as shown on the drawings a Spirotherm steel, Taco Series 4900, Caleffi, Armstrong, Wessels, or approved equal air elimination and dirt separator. All fittings shall be fabricated steel, rated for 150 psig design pressure and selected for less than 1 foot of water pressure drop and velocity not to exceed 4 feet per second through the unit at specified GPM. All units shall include an integral copper bundle of Spirotubes or approved equal, to act as the turbulence suppressive coalescing medium which must completely fill the fitting's internal area. Units are to remove free and entrained air during system start up and continue to eliminate dissolved air and dirt through continual circulation and the coalescing action of the Spirotubes. Each fitting is to have a separate air and venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated brass air vent. There shall be no restriction in the connection from the venting chamber to the vent. The fittings are to include a valve side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Units shall include a bottom connection for use as a blow down connection for periodic cleaning. Unit shall have the bottom of the vessel extended for dirt separation with the system connection nozzles equal distant from the top and bottom of the vessel. Air separator shall be primed and finished in rust resistant paint. Units shall be Spirovent dirt models of the size required to meet pressure drop and velocity criteria.
- B. A blowdown connection and valve shall be provided to facilitate routine cleaning of the strainer and the separator. Unit shall include a removable lower head to facilitate removal of the tube assembly for cleaning.
- C. A manufacturer's data report for pressure vessels, for U-1 as required by the provisions of ASME Boiler and Pressure Vessel code, shall be furnished for each air separator upon request. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.
- D. Conventional tangential or centrifugal non-coalescing air separators shall not be acceptable.

2.12. EXPANSION TANKS

- A. Furnish and install as shown on the drawings, pre-pressurized captive air bladder type expansion tank pre-charged with air. Tank shall be suitable for a maximum working pressure of 125 psi and constructed and certified to ASME Section VII. It shall have a replaceable elastomeric bladder suitable for a maximum operating temperature of 240 degrees F (115 degrees C). Expansion tanks shall be primed and finished in rust resistant paint. It shall have an integral steel base ring for vertical mounting and saddle for horizontal mounting. Expansion tank shall be as manufactured by Taco, Bell & Gossett, Wessels, Amtrol, Armstrong or as approved equal.

2.13. HORIZONTAL HOT WATER UNIT HEATERS

- A. Provide and install horizontal hot water unit heaters of the size, capacity and electrical characteristics as indicated on the contract drawings. Horizontal unit heaters shall be Trane Model S, Dunham Bush, Modine, or approved equal.
- B. Casing shall be two-piece with "picture frame" front formed into wrap around sides, top and bottom. Furnish each unit with louvered fin diffuser for versatility in lateral diffusion. Casing shall be 18 gauge back panel with deep-drain fan orifice for extreme rigidity. Steel

supply and return pipe top connectors bolted to back. Casings phosphatized to prevent corrosion and finished with a green baked enamel finish.

- C. Fan shall be high efficiency Model A with aluminum blades, factory balanced and sturdy for standard applications.
- D. Coils shall be hot water, single tube single serpentine design. Fins shall be aluminum sigma-flow, mechanically bonded to seamless copper tubing. All coils one-row deep in air flow direction. Coils shall be tested at 300 psig air under water. Coils shall be suitable for operation at 200 psig or 325 degrees F.
- E. Motors shall be totally enclosed, class "B" insulated shaded pole and permanent split capacitor. All motors shall have built-in overload protection. Sleeve bearing motors can be oiled. Ball bearing motors are permanently lubricated. Units shall be U.L. listed.

2.14. VERTICAL HOT WATER UNIT HEATERS

- A. Provide and install vertical hot water unit heaters of the size, capacity and electrical characteristics as indicated on the contract drawings. Vertical unit heaters shall be Trane Model P, Dunham Bush, Modine, Rittling, or approved equal.
- B. Casing shall be formed by two (2) square steel plates. Bottom plate forms orifice for easy air delivery. Air ports shall be stamped in top plate for easy removal for low final air temperature.
- C. Fan shall be high efficiency Model A with aluminum blade, factory balanced and sturdy for standard applications. Furnish each unit with discharge diffuser.
- D. Coils shall be hot water, rectangular 3 or 4 sided, one pass, multiple circuit, with sigma flow fins mechanically bonded to tubes. Coils shall be seamless copper tubing. Coils shall be tested at 300 psig air under water. Coils shall be suitable for operation at 200 psig or 325 degrees F.
- E. Motors shall be totally enclosed, class "B" insulated shaded pole and permanent split capacitor. All motors shall have built-in overload protection. Sleeve bearing motors can be oiled. Ball bearing motors are permanently lubricated. Units shall be U.L. listed.

2.15. EXTERIOR PIPE ROLLER SUPPORTS

- A. Furnish and install pipe roller supports for all exterior piping as indicated on contract drawings. Pipe roller supports shall be constructed of heavy gauge galvanized steel, continuous welded corner seams, 2 x 4 treated wood nailer, heavy gauge galvanized steel counterflashing with galvanized steel channel track attached.
- B. Roller assembly shall consist of galvanized steel channel track, galvanized steel fittings, washers, nuts, and painted cast iron roller. Installation shall permit both vertical and horizontal adjustment. Units shall be Pate Model RAC or approved equal.

2.16. CARBON MONOXIDE DETECTORS

- A. Provide and install plug-in type, U.L. listed, carbon monoxide (CO) detector at all locations

indicated on the Contract Drawings.

- B. The carbon monoxide detectors shall alarm whenever the CO concentration is exceeded. Carbon monoxide detectors shall be manufactured by First Alert, Night Hawk or approved equal.
- C. Units shall be suitable for electrical characteristics as scheduled on the Contract Drawings.

2.17. AIR MONITORING STATIONS (ERV, H&V UNIT, & CARBON MONOXIDE MAKE-UP AIR UNITS)

A. General: Provide complete air monitoring station for ERV units and kitchen make-up air units, as indicated on drawings. The air monitoring station shall include airflow measuring stations, static pressure probes and electronic velocity pressure transmitter. All components shall be of the same manufacturer. The manufacturer shall be Air Monitor, Gold Series Ebtron Thermistar, or as approved equal. An air monitor station shall be provided for each supply duct main, exhaust duct main, and return duct main as indicated on contract drawings. All air flow monitoring stations shall be fully externally insulated to prevent condensation.

B. Air Monitor Airflow Measuring Stations

1. Provide where indicated, airflow measuring stations capable of continuously monitoring the fan or duct capacities (air volumes) they serve.
2. Each airflow measuring station shall contain multiple total and static pressure sensors positioned at the center of equal area of the station cross-section and interconnected by their respective averaging manifolds. For stations of 4 square feet or less, one total and one static pressure sensor shall be present for every 16 square inches of station area respectively. For stations of larger area, one total and one static pressure sensor shall be present for every 36 square inches of station area respectively.
3. The airflow measuring station shall be fabricated of a minimum of 14 ga. galvanized steel, welded casing in 8-inch depth with 90 degree connecting flanges in a configuration and size equal to that of the duct it is to be mounted into. Each station shall be complete with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to the casing, total and static pressure sensors located on an equal area basis and connected to symmetrical averaging manifolds, internal piping, and external pressure transmitter ports. An identification label shall be placed on each station casing listing model number, size, area, and specified airflow capacity.
4. Cell construction shall be 3/8-inch .003-inch, type 3003 aluminum, expanded.
5. The maximum allowable pressure loss through the station shall not exceed .015-inch wc at 1000 fpm, or .085-inch wc at 2000 fpm. Each station shall be capable of measuring the airflow rate within an accuracy of 2 percent as determined by U.S.G.S.A. certification tests. The stations shall have a self-generated sound rating of less than NC 40, and the sound level within the duct shall not be amplified, nor shall additional sound be generated.

6. Stations shall be Fan-E type as manufactured by Air Monitor Corporation, Paragon or as approved equal.

C. Air Monitor Duct Static Pressure Traverse Probes

1. Provide where indicated duct static traverse probe capable of continuously monitoring the duct or system static pressure it serves.
2. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Said sensors shall not protrude beyond the surface of the probe.
3. The duct static traverse probe shall be of extruded aluminum construction and (except for 3/4-inch diameter probes with lengths of 24-inches or less) be complete with threaded end support rod, sealing washer and nut and mounting plate with gasket and static pressure signal fitting.
4. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5 percent.
5. The duct static pressure traverse probe shall be the STAT-probe/1 as manufactured by the Air Monitor Corporation, Paragon or as approved equal.

D. Air Monitor Electronic Velocity Pressure Transmitters

1. The electronic control-instrument components shall be of industrial process control quality with operating features described herein and capable of producing the outlined performances. Commercial grade control-instruments, devices, are not acceptable.
2. The electronic differential pressure transmitter shall include an automatic zeroing circuit capable of automatically readjusting the transmitter zero at predetermined (adjustable) time intervals while retaining (locking in) the output signal. The electronic differential pressure transmitter shall be capable of receiving signals of duct total and static pressures, and of amplifying and scaling the sensed differential pressure into a 4-20 mADC or 0-5 (0-10) VDC output signal linear to differential pressure, within the following minimum performance criteria:

Zeroing	Automatic, within 0.1 percent of operating span, on 4 to 256 minute intervals (selectable)
Spans	Factory custom spanned, coordinated with system, ranges from 0 to .01-inch to 0 to 10.0-inches. Field adjustment +20 percent of span.
Accuracy	+ 0.25 percent of span
DeadBand and Hysteresis (Combined):	Less than 0.2 percent of span

Linearity:	+ 0.2 percent of span
Repeatability:	0.15 percent of span
Response:	0.5 second for 98 percent full span input
Power Supply:	24 VAC, 20 to 40 VDC, selectable; 4 wire

3. Coordinate requirements with the buildings direct digital control system to perform the required sequence of operation.
4. The pressure transmitter shall be the VELTRON series 5000AZ as manufactured by the Air Monitor Corporation, Paragon, Greenheck, Johnson Controls, or as approved equal.

2.18. WATER TREATMENT SERVICES

- A. Complete chemical water treatment service shall be provided by an organization regularly engaged in water treatment, ARC, Inc., RCCO Corp., Aquatel Ind., Inc., Mogul Corp., Oilin, Inc., HVAC Services, Inc., Feedwater Treatment Systems, Inc., Eco-Lab, or approved equal. The service shall provide all equipment, chemicals and labor necessary to prevent corrosion, inhibit scale build-up and minimize organic growth for a period of 2 years starting from building acceptance. Service visits for the purpose of adding chemicals to feeding equipment, regulating bleed-off, inspecting and adjusting water treatment equipment, and obtaining samples of laboratory analysis shall be performed at monthly intervals for closed systems and every two weeks for open systems during the entire guarantee period. Chemicals shall not be injurious to water side equipment and construction materials. Records of all injurious to water side equipment and construction materials. Records of all service visits, chemical additions, laboratory tests, etc., shall be maintained and shall be provided to owner after each visit during guarantee period. Instruct mechanical contractor in field on piping and wiring of chemical feeding equipment.
- B. Systems to be protected shall include hot water heating system. Services shall include flushing and cleaning of piping systems specified under Division 23 Section, "HVAC Piping, Fittings, and Valves" section, furnishing and installing all chemical treatment equipment and accessories to perform the water treatment specified below. Maintain complete records of the treatment program for each system.
- C. Contractor shall perform an analysis of the building water supply as a basis of the chemical treatment. Contractor shall provide the Owner with written instructions for chemical feeding bleed-off, blowdown control and testing procedures, provide all required chemicals during the guarantee period, and provide all required test kits.
- D. Contractor shall maintain the following conditions in each system:

SYSTEMS	Hot Water System
ph	7.0 to 10.0

Inhibitor for Scale & Corrosion Cycles	---
Cycles*	---
Organic	---
Buffered Nitrate	1000 ppm to 180 degrees F 2000 ppm to 180 degrees F
Chromate (Low)	
Molybdate	50 to 100 ppm
Sulfite	---
Sodium Nitrite	1000 to 1500 PPM
Corrosion Inhibitor	
*Actual cycles of concentration to be determined from analysis of make-up water.	
Use Inhibited Glycol supplies by Manufacturer.	

- E. Chemical Feeding Equipment: Provide chemical feeding equipment, as specified below, to introduce chemicals into each system only when the system is operating.
 - 1. Closed Recirculating Systems
 - a. Five (5) gallon steel by-pass feeder installed across circulating pump suction and discharge lines, with tank and piping insulated using the same thickness and type of insulation as provided for the piping system. Provide filter. Unit shall contain quick opening cap and shall be suitable for working pressure of 175 psig. Tank shall be primed and finished in baked enamel paint.
 - 2. Replace bypass feeder filter monthly during the entire 2-year warranty period.
- F. Boilers shall be boiled out with an alkaline type boiling out compound to remove grease, oil, mill scale and other foreign matter. The compound should be used at the rate of 1-1/2 pounds per 20 boiler horsepower. After boiling out period, the boilers should be completely drained, flushed, refilled with fresh water and vented. All water treatment chemicals shall comply with Delaware Water Resources laws and regulations.
- G. Closed Recirculating Systems shall be filled and sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the

system continues to circulate. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and if PH exceeds the PH of the make-up water, flushing shall be resumed.

2.19. ENERGY RECOVERY VENTILATOR

- A. Provide and install ERV's (Energy Recovery Ventilators) as shown on contract drawings. ERV's shall be Model AAONAIRE as manufactured by Aaon, Venmar, Greenheck, Valent, or approved equal.
1. Energy Recovery Ventilator shall be as manufactured by Aaon or approved equal provided all specifications are met. Aaon Model AAONAIRE equipment is used as the basis of design. Units shall be listed per UL 1812 and bear the UL label. Energy transfer ratings shall be in accordance with ASHRAE Standard 84 and ARI 1060. Wheels shall be ARI 1060 certified. Performance to be as scheduled on plans. Exhaust discharge and outside air intake shall not be located on the same side on rooftop units.
 2. Unit shall be of internal frame type construction of galvanized steel. All frame and panel shall be G90 galvanized steel. Where top panels are joined there shall be a standing seam to insure positive weather protection. All metal-to-metal surfaces shall be sealed, requiring no caulking at job site. Unit base to be designed for roof mounting.
 3. Unit casing to be insulated with 1 in - 3 lb. fiber-glass with Foil-Scrim-Kraft facing. Insulation in accordance with NFPA 90A and tested to meet UL 181 erosion requirements and secured to unit with water proof adhesive and permanent mechanical fasteners.
 4. Wheel shall be of the enthalpy type for both sensible and latent heat recovery and be designed to insure laminar flow. Efficiency ratings shall be based on tests conducted in accordance with ASHRAE 84 and laminar flow. Efficiency ratings shall be based on tests conducted in accordance with ASHRAE 84 and ARI 1060 standards. Desiccant shall be silica gel for maximum a latent energy transfer. Wheel shall be constructed of light weight polymer or aluminum media to minimize shaft and bearing loads. Polymer or aluminum media shall be mounted in a stainless steel rotor for corrosion resistance. Wheel design shall consist of removable segments for ease of service and/or cleaning. Segments shall be removable without the use of tools. Silica gel desiccant shall be permanently bonded to wheel media to retain latent heat capability after cleaning. Energy recovery device shall transfer moisture entirely in the vapor phase.
 5. All components shall be easily accessible through removable hinged doors for both exhaust fan, supply fan, filter and damper compartments. Energy recovery wheels (smaller than 54 in.) shall be mounted in a slide-out track for ease of inspection, removal and cleaning.
 6. Refer to Division 23 Section, "Common Work Results for HVAC" for VFD motor bearing protective rings.

B. Fans

1. Centrifugal blowers shall be backward inclined and housed in a scroll to maximize fan efficiency. Fans shall be AMCA certified for air performance. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds. Blowers shall enable independent balancing of exhaust and supply airflow with adjustable sheaves for motors 10 horse power and below. Fans shall be located in draw-through position in reference to the energy recovery wheel.
2. Motors shall be inverter duty energy efficient, complying with EPACT standards, for variable speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be fully machined cast. Energy wheel motors shall have integral overload protection.
3. All internal electrical components shall be pre-wired for single point power connection. All electrical components shall be UL listed, approved or classified where applicable and wired in compliance with the National Electrical Code. The control center shall include a weatherproof disconnected switch, motor starters, control circuit fusing, control transformer for 24 VAC circuit and motor starters. Motor starters shall consist of a contactor and Class 20 adjustable overload protection and shall be provided for all motors in the unit.
4. Energy recovery ventilators housings shall be factory primed and painted in color as selected by Architect.
5. Both the supply and exhaust air streams shall be filtered to protect the enthalpy wheel. Furnish and install 30 percent pleated filters (Farr 30/30 or approved equal), filter racks and access panels. Provide one (1) set of additional filter media to Owner for each unit.
6. Furnish exhaust and outside air intakes with hoods provided with bird screens and sound lining.

C. Direct Expansion (DX) Cooling System

1. Remote Air-Cooled Condenser Section:
 - a. The remote condensing section shall be equipped with vertical discharge axial flow direct drive fans. Direct drive fans shall be directly connected to and supported by the motor shaft.
 - b. The condenser coils shall be sloped at least 30° to protect the coils from damage.
 - c. Condenser coils shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - d. Condenser coil fin design shall be sine wave rippled.
 - e. Condenser coils to be sized for a minimum of 10°F of refrigerant sub-

cooling.

2. Evaporator Coils:
 - a. Evaporator coil shall be copper tube with aluminum fins mechanically bonded to the tubes.
 - b. Evaporator coil fin design shall be sine wave rippled.
 - c. Evaporator coil shall have galvanized steel end casings.
 - d. Evaporator coil shall have equalizing type vertical tube headers.
 - e. Evaporator coil shall be furnished with a thermostatic expansion valve.
 - f. Evaporator coil shall be furnished with a double sloped drain pan for the positive drainage of condensate.
3. Refrigeration System:
 - a. Compressors shall be scroll type with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators.
 - b. Compressors shall carry a 5 year non pro-rated warranty.
 - c. Each compressor shall be individually stage for capacity control. All units over 7 tons shall be multiple stage and shall have a minimum of 2 stages of capacity control.
 - d. Compressors shall be mounted in an isolated compartment to permit operation of the unit without affecting air flow when the door to the compartment is open.
 - e. Each refrigerant circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
 - f. Each refrigerant circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant controls. Each refrigeration circuit shall be equipped with Schrader type service fittings on both the high pressure and low pressure sides.
 - g. Each refrigeration circuit shall be equipped with refrigerant liquid line driers.
 - h. Unit shall be fully factory charged with R-410A refrigerant.
 - i. Each compressor shall be equipped with suction and discharge service/isolation valves.
 - j. The first on and last off compressor shall be a digital scroll compressor and shall be capable of capacity modulation from 10-100%.
4. Unit shall dehumidify using a hot gas reheat coil, modulating hot gas reheat control valves piped to the lead refrigerant system, and an electronic controller. A factory-wired, field installed, supply air temperature sensor and a field-installed space humidity sensor shall be provided to control the amount of reheat. The supply air temperature set point shall be adjusted on the electronic controller within the controls compartment.
5. All compressors shall be provided with a (5) five year parts and labor warranty.
6. Furnish each unit with an insulated, stainless steel drain pan under the coil extending past the coil to ensure condensate retention.

D. Hydronic Coil:

1. Hot water coils shall be furnished to meet the performance requirements set forth in the schedule. All coils shall have performance certified in accordance with ARI Standard 410. Coils shall be arranged in the unit for horizontal air flow and selected for a maximum face velocity as scheduled. Install coils such that headers and return bends are enclosed by unit casings.
2. Coil casing shall be constructed of heavy gauge galvanized metal with aluminum die-formed corrugated fins and guide channels to create turbulent wiping behind the tubes. The fins shall have drawn collars, be belled and mechanically expanded to firmly bound the copper tubes to the fins. All coils shall be installed on tracks for easy removal from the energy recovery unit.
3. Drainable water coils shall be designed to operate at 250 psig design working pressure and up to 300 degrees F and shall be tested with 325 psig compressed air under water. Circuiting shall provide free draining and venting when installed, counter flow of air and water with water velocities not to exceed seven feet per second and without exceeding the water pressure drops scheduled. All coils must have same end connections regardless of the number of rows deep. Clearly label supply and return headers on outside of units such that direction of coil water flow is counter to direction of unit airflow.
4. Construct coils of configuration plate fins and seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion tubes. Do not use soldering or tinning in bonding process.
5. Construct coil casings of Galvanized G90-U steel with formed end supports and top and bottom channels. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through air stream.
6. Coil grommets shall be provided on all coils to completely seal the area between the coil connection and the unit casing.
7. Control valves shall be furnished by ATC subcontractor and installed by the mechanical contractor.

E. Demand Control Ventilation Components:

1. Energy recovery ventilator fans shall be controlled by a variable frequency drive. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The variable frequency drive shall be factory mounted in the unit cabinet and wired.
2. Energy recovery ventilator shall be equipped with demand control ventilation capabilities that enable the varying of outdoor air and exhaust air volumes based on building occupancy. A sensor shall be located in the exhaust air stream to monitor average CO2 levels of the occupied spaces. A variable frequency drive

shall receive a 0-10 volt signal from the CO2 sensor and control the outdoor air volume to maintain a maximum of 1,000 ppm of CO2 in the occupied space. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The sensor and variable frequency drive shall be factory mounted and wired. Additional space CO2 sensors shall be required (refer to plans for quantity and locations) and interlocked with ERV demand controlled ventilation system.

3. Furnish each energy recovery ventilator with the following:
 - a. Supply air fan variable frequency drive.
 - b. Exhaust air fan variable frequency drive.

F. Extra Materials:

1. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
2. Filters: Furnish one set of each type of filter.
3. Fan Belts: Furnish one set of belts for each belt drive fan in energy recovery ventilator.
4. Wheel Belts: Furnish one set of belts for each belt driven energy wheel.

G. Digital Precise Air Controller

1. The unit shall include a field installed microprocessor based unit controller which controls the operation of the unit including the compressor(s), condenser fan motor(s), supply fan motor, heater, hot water heater, and modulating hot gas reheat.
2. Field mounted and wired is an outside air temperature sensor and suction pressure transducer. Field wired for field installation is a supply air temperature sensor. Furnished with the unit for field installation are a space air temperature sensor with temperature set point reset and unoccupied override and a space humidity sensor.
3. Controller
 - a. Field installed controller shall be capable of independent stand alone operation and have the ability to communicate and integrate with widely-used building automation systems. Controller shall be IP addressable and be able to reside on a TCP/IP network. Controller shall have 2 RJ-45 Ethernet ports, 1 RS-232 port, and 1 RS-485 port.
 - b. Controller shall require a PC with the AAON configuration tool software for configuration and programming. With graphical user interface over IP option controller can be configured through a browser over the internet.
 - c. Controller shall have a full calendar schedule for occupied, unoccupied, and holiday scheduling.

- d. Controller shall retain all programmed values in non-volatile memory in the event of a power failure.
- e. Configuration tool software, when connected to unit controller, shall indicate unit status, set points, and faults.
- f. With modulating hot gas reheat a field installed space humidity sensor and a field installed supply air temperature sensor will be furnished to control the amount of reheat. An electronic modulating reheat controller will also be furnished. The supply air temperature set point shall be set on the modulating reheat controller.
- g. Furnish controls with necessary interfaces to communicate via BACNET/IP to a Building Automation System.

H. Unit Sequence of Operation

- 1. Refer to Division 23 Section, "Instrumentation and Controls of HVAC & Plumbing Systems".

PART 3. EXECUTION

3.1. EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all equipment may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Verify structure, mounting supports and membrane installations are completed to the proper point to allow installation of roof mounted equipment, where applicable.
- C. Examine rough-in requirements for all piping systems to verify actual locations of piping connections prior to installation.
- D. Verify that electrical work installation is in accordance with manufacture's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment installer. Coordinate sizes of all thermal overloads with Division 26.
- E. Do not proceed until unsatisfactory conditions have been corrected.
- F. Provide wiring diagrams of all equipment as specified in Division 23 Section, Common Work Results for HVAC.

3.2. GENERAL INSTALLATION REQUIREMENTS

- A. Install all equipment in accordance with manufacturer's installation instructions, in accordance with state and local code requirements, and in accordance with the contract drawings. Install all equipment plumb and level, to tolerances as required by the manufacturer of each item of equipment. Maintain manufacturer recommended clearances around and over all equipment. Boiler and water heater minimum clearances shall be provided per the State of Delaware Requirements.
- B. Coordinate vibration isolation requirements with all equipment in accordance with

Division 23 Section, Vibration Controls for HVAC, Plumbing and Fire Protection Equipment.

- C. Coordinate all electrical requirements with Division 26.
- D. Coordinate all indoor and outdoor equipment pad locations and sizes with approved shop drawing submittals. Provide operating weights of equipment to Structural Engineer for review. Coordinate equipment pad locations and sizes with the Concrete Contractor or General Contractor. Furnish anchor bolts which are to be inserted in concrete pads to concrete installer.
- E. Verify piping arrangements of all equipment with the contract drawings. Piping details shall be strictly adhered to concerning valves, fittings, components, etc. At coils, where a rebuildable and repairable autoflow valve is installed in the line without the need for draining or shutting of the water, the same may be utilized as the isolation valve and additional shut-off valve is not required.
- F. Connect all equipment, devices and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- G. Testing: After installing HVAC equipment, devices and components and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- H. Remove and replace malfunctioning units with new units and retest.
- I. All mechanical penetrations or terminations in exterior walls shall be flashed and caulked watertight.
- J. Arrange for equipment such as boilers, air handling units, energy recovery units, H & V unit, carbon monoxide system makeup air unit to be shipped to project in modules where space constraints require the same. Field erect components as required.

3.3. FIELD QUALITY CONTROL

- A. Where indicated provide the services of a factory authorized service representative to examine the field assembly of components, installation, piping, electrical connections, controls, and clearances. Submit factory start-up check list to Engineer for information purposes. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.
- B. Where factory start-up of equipment is not specified, provide field start-up by qualified technician to examine the field assembly of components, installation, piping, electrical connections, controls and clearances. Record equipment manufacturers standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

- C. Charge all refrigerant systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant and oil.
- D. Fill all hydronic systems with water [and/or antifreeze] [(when required) after flushing and test for leaks. Repair leaks and replace lost water [and/or antifreeze]. Coordinate with water treatment contractor.
- E. Submit to Engineer a written table of all relief valve and make-up water valve settings for each system. Provide an additional copy in the Operations and Maintenance Manuals.
- F. Verify proper motor sizes, voltages, thermal overloads, nameplate data, etc. All equipment voltages and current shall be recorded to insure that motors are operating below their service factors. Test and Balance Engineer shall record electrical data before continuous or permanent operation.

3.4. DEMONSTRATION

- A. Provide the services of a factory authorized service representative to provide start-up and to demonstrate and train the Owner's maintenance personnel.
- B. Place equipment into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.
- C. Training:
 - 1. Train the Owner's maintenance personnel on start-up and shut-down procedures, trouble shooting procedures, lubrication, servicing procedures and preventative maintenance schedules/procedures. Review with the Owner's personnel, the contents of the operation and maintenance data specified in Division 23 Section, Common Work Results for HVAC.
 - 2. Submit operation and maintenance data as soon as possible prior to project close-out. Operations and maintenance data shall be submitted to the Owner for review and comment prior to submission to the Engineer.
 - 3. Schedule training with the Owner through the Architect and/or Engineer with at least seven (7) days prior notice.
- D. Contractor shall demonstrate removal and replacement of filters at all pieces of equipment with filters in the presence of the Owners representative.

3.5. CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan and equipment interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering air face.

3.6. AIR HANDLING UNIT INSTALLATION REQUIREMENTS

- A. Install in conformance with ARI 435. Install air handling units level and plumb, according

to manufacturer's written instructions.

- B. Install AHU's with resilient mounting and flexible electrical leads.
- C. Install flexible connections as hereinafter specified at all duct connections.
- D. Comb out fins on AHU coils where deformed or bent. Replace or repair broken fins.
- E. Install coils level. Install cleanable tube coils with 1:50 pitch.
- F. Make connections to coils with unions and flanges.
- G. Provide air tight seals between coils and duct or casings. Gasket all access panels, door openings and inspection windows. Seal all joints between sections.
- H. Insulate all headers outside air flow as specified for piping.
- I. Arrange installation of units to provide access space around air handling units for service and maintenance.
- J. Adjust damper linkages for proper damper operation.
- K. Install air tight seals at all air handling penetration points, including pipe penetrations at the coils, unused maintenance - only drain openings, and any penetrations for electrical wiring.

3.7. AIR COOLED CONDENSING UNIT INSTALLATION REQUIREMENTS

- A. Mount outdoor unit as detailed on drawings.
- B. Supply initial charge of refrigerant and oil as required.
- C. Install refrigerant piping between condensing unit and indoor unit per manufacturer's instructions.
- D. Size refrigerant piping in accordance with condensing unit manufacturer's instructions.
- E. Set condensing unit on vibration isolators and level.
- F. Comb out fins on condensing unit where deformed or bent. Replace or repair broken fins.
- G. Coordinate electrical characteristics with equipment supplied.

3.8. DUCTLESS UNITS EQUIPMENT INSTALLATION REQUIREMENTS

- A. Mount indoor and outdoor units as detailed on contract drawings.
- B. Supply initial charge of refrigerant and oil as required.
- C. Install all interlock and control wiring between indoor units, outdoor units thermostats, and condensate pumps.

- D. Install indoor ceiling cassette on vibration isolators.
- E. Install outdoor units on concrete pads as indicated on drawings.
- F. Comb out fins on condensing unit where deformed or bent. Replace or repair broken fins.
- G. Install condensate lift pumps, float switches, alarm, unit shut down wiring and detection block units per manufacturer's recommendations.
- H. For wall mounted units, locate condensate pumps above ceiling. Install all piping, tubing between indoor unit, adapter, detection block, and condensate pump.
- I. For wall mounted units field wire power wiring, alarm circuits, control cable, safety circuit connection, alarm, and condensate pump. Condensate pump shall be powered from indoor unit power wiring. Coordinate condensate pump electrical characteristics with indoor unit electrical characteristics.
- J. Install wind baffles when required for low ambient operation. Locate wind baffles facing the predominant wind direction in winter.

3.9. ELECTRIC HEATING EQUIPMENT INSTALLATION REQUIREMENTS

- A. Examine heating units for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Connect heating units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- C. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.
- D. Install and mount electric radiant heat panels from building structure as required to accommodate ceiling type. Field furnish all accessories necessary to mount radiant heat panels.

3.10. FAN INSTALLATION REQUIREMENTS.

- A. Install fans with resilient mounting and flexible electrical leads.
- B. Install flexible connections and vibration isolators as specified in Division 23 Section, Common Work Results for HVAC and Division 23 Section Vibration Controls for HVAC, Plumbing and Fire Protection Equipment. Ensure metal band of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide safety screens/guards on all fans and permanently mount after final testing and balancing.

- D. Where indicated, pipe scroll drains with valve, full size to nearest floor drain. Pipe material shall be 316 stainless steel. Where indicated install and pipe grease collectors with valve, union, and discharge to closest floor drain.
- E. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fans have been test run under operation.
- F. Provide sheave required for final air balance.
- G. Install fans according to manufacturer's written instructions.
- H. Adjust damper linkages for proper damper operation.
- I. Adjust belt tension.
- J. Lubricate bearings.
- K. Replace fan and motor pulleys and belts as required to achieve design conditions.
- L. Mount, install, and wire speed controllers for direct drive fans. Speed controllers for direct drive fans shall be mounted adjacent to fan and wired in accordance with the NEC.

3.11. BOILER INSTALLATION REQUIREMENTS

- A. Install boilers in accordance with NFPA-54 Boiler and Pressure Vessel Safety Act including ASME CSD-1, Amendments and Addenda, latest edition, and State of Delaware Requirements. Coordinate inspection of boiler by local Boiler Inspector or authority having jurisdiction. Correct any and all violations noted by Boiler Inspector at no additional cost to the Owner.
- B. Install boilers on concrete housekeeping pads.
- C. Provide connections of fuel source piping in accordance with codes listed above. All gas regulators and gas pressure relief valves shall be piped to the building exterior and terminated with a gooseneck and vermin screen as required in CSD-1. Gas regulator and gas relief valve pipe material shall be in accordance with A.S.M.E. Code.
- D. Provide piping connections and accessories as specified and detailed on drawings. For hot water piping all piping up to the first OS&Y gate valve on each side of the boiler shall be welded, flanged or screwed. Grooved joint piping is not acceptable until after the OS&Y gate valve on each side of the boiler.
- E. Pipe all relief valves to nearest floor drain. Support relief valve piping in accordance with A.S.M.E. requirements. Relief valve pipe material shall be in accordance with A.S.M.E. Code. Install no more than one (1) elbow on safety relief valve discharge pipe located close to the valve outlet downstream of the union.
- F. Provide for connection to electrical services.
- G. Provide for connection to gas pilot piping including strainer, shut-off valve, unions, and regulators.

- H. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards.
- I. Assemble boiler sections in sequence and seal between each section. Assemble boiler trim according to manufacturer's written installation instructions.
- J. Install electrical devices furnished with boiler, but not specified to be factory mounted. Mount, install, and wire low water cutoffs and gas train valves. Low water cut offs and gas train valves shall be installed per manufacturers recommendations and wired in accordance with the National Electric Code.
- K. Connect breeching to boiler outlet, full size of outlet.
- L. Electrical: Comply with applicable requirements in Division 26.
- M. Ground equipment.
 - 1. 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.
- N. Manufacturer's Field Service: Engage a factory authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Submit flue gas and combustion analysis reports to Engineer.
 - 3. Record design and actual draft available at appliance vent connection.
- O. Hydrostatically test assembled boiler and piping, according to applicable sections of the ASME Boiler and Pressure Vessel Code.
- P. Flush and clean boilers on completion of installation, according to manufacturer's written instructions.
- Q. After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's touch up paint.
- R. Furnish and install condensate neutralizers with lime chips and pipe discharge as indicated. Connect condensate neutralizers to boilers and flue pipes.
- S. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

- T. Examine mechanical spaces for suitable conditions where boilers will be installed.
- U. Proceed with installation only after unsatisfactory conditions have been corrected.
- V. Equipment Mounting:
 - 1. Install boilers on cast-in-place concrete equipment base(s).
 - 2. Mount valves and devices at heights required by the Boiler Inspector.
- W. Install gas-fired boilers according to NFPA 54.
- X. Assemble and install boiler trim.
- Y. Install electrical devices furnished with boiler but not specified to be factory mounted.
- Z. Install control wiring to field-mounted electrical devices.
- AA. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. All boiler relief valve and drain piping shall be Type L copper piping.
- BB. Install piping adjacent to boiler to allow service and maintenance.
- CC. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve. Drain valves shall be brass, ball type and not less than 1-inch. Pipe ends shall be cut at 45 degree angle to prevent a cap or plug from being installed.
- DD. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. All relief valve discharge piping shall be fully supported to prevent undue stress or strain.
- EE. Connect gas piping to boiler gas-train inlet with union and shut-off valve. Piping shall be at least full size of gas train connection. Provide a reducer if required. Furnish and install gas pressure regulators as required.
- FF. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- GG. Connect flow switch to hot water piping and interlock with boiler and ATC system.
- HH. Install piping from safety relief valves to nearest floor drain.
- II. Boiler Venting:
 - 1. Install flue venting kit, flue stack thermometer, roof curbs, cleanouts, and combustion-air intake.
 - 2. Connect full size to boiler connections.
 - 3. For condensing boilers connect flue and combustion air ducts to full size boiler.

- JJ. Ground equipment according to Division 26, Section "Grounding and Bonding."
- KK. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- LL. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Perform installation and startup checks according to manufacturer's written instructions.
 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- MM. Remove and replace malfunctioning units and retest as specified above.
- NN. Prepare test and inspection reports.
- OO. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, 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.
- PP. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 4. Repeat tests until results comply with requirements indicated.
 5. Provide analysis equipment required to determine performance.
 6. Provide temporary equipment and system modifications necessary to dissipate the

heat produced during tests if building systems are not adequate.

7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

QQ. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

3.12. HVAC PUMP INSTALLATION REQUIREMENTS

- A. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- B. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.
- C. Provide drains for bases and seals, piped to and discharging into floor drains.
- D. Check, align, and certify alignment of base mounted pumps prior to start-up. Prior to starting pumps, the alignment of the pumps and their motors or other drivers shall be carefully checked. Alignment should be checked for both offset and angularity. Alignment by means of an Ames dial, Laser or equivalent shall be accomplished for all pumps. Alignment by straight edge across the pump couplings shall not be acceptable.
- E. Install close coupled and base mounted pumps on concrete housekeeping pads, with anchor bolts, set and level, and grout in place. See Division 23 Section, Vibration Controls for HVAC, Plumbing and Fire Protection Equipment for inertia pad requirements. After alignment is correct, tighten foundation bolts evenly but not too firmly, completely fill baseplate with non shrink, non metallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
- F. Lubricate pumps before start-up.
- G. Provide side-stream filtration system for base mounted pumps. Install across pump with flow from pump discharge to pump suction from pump tapings. Install flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valves. Install 30 micron filter for start-up and 5 micron filter for system operation.
- H. Install pumps according to manufacturer's written instructions.
 1. Install pumps according to HI 1.1 1.5, Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.
- I. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- J. Suspend in line pumps using continuous thread hanger rod and vibration isolation hangers.
- K. Set base mounted pumps on concrete foundation. Disconnect coupling halves before

setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1 1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.13. HYDRONIC EQUIPMENT AND SPECIALITIES INSTALLATION REQUIREMENTS

- A. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents provide vent tubing to nearest drain.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Provide valved drain and hose connection on strainer blow down connection.
- F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- G. Support pump fittings with floor mounted pipe and flange supports.
- H. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment and in accordance with ASME requirements.
- I. Pipe all relief valve outlets to nearest floor drain.
- J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- K. Install equipment exposed to finished area after walls and ceiling are finished and painted. Avoid damage.
- L. Protection: Provide finished cabinet units with protective covers during balance of construction.
- M. Unit heaters: hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- N. Testing: After installing and connecting units, demonstrate product capability and compliance with requirements.
- O. Remove and replace malfunctioning units with new units and retest.

3.14. WATER TREATMENT INSTALLATION REQUIREMENTS

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning. Open bypass valves on coils and close isolation valves on coils during initial flushing.
- C. Verify that electric power is available and of the correct characteristics.
- D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.
- E. Flush open systems and closed systems with clean water for one hour minimum. Drain completely and refill.
- F. Remove, clean, and replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- H. Test and submit antifreeze concentration where the same is utilized.

3.15. SPLIT SYSTEM EQUIPMENT INSTALLATION REQUIREMENTS

- A. Mount indoor and outdoor units as detailed on contract drawings. Install units level and plumb.
- B. Supply initial charge of refrigerant and oil as required.
- C. Install all interlock and control wiring between indoor units, outdoor units and thermostats.
- D. Install all indoor and outdoor units on vibration isolators.
- E. Install outdoor units on concrete pads as hereinbefore specified or on roof curb as indicated on drawings.
- F. Install refrigerant suction, liquid, lines between indoor and outdoor units per manufacturer's instructions. Connect precharged refrigerant tubing to components quick connect fittings. Install tubing to allow access to unit.
- G. Size all refrigerant piping per manufacturer's instructions.
- H. Connect drain lines to condensate pans.
- I. Provide auxiliary drain pans on all horizontal units. Pipe drain to closest floor drain or as indicated on drawings.
- J. Comb out evaporator coil and condensing unit fins.

3.16. ENERGY RECOVERY VENTILATOR INSTALLATION REQUIREMENTS

- A. Examine areas to receive energy recovery units for compliance with requirements for installation tolerances and other conditions affecting performance of energy recovery units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Install energy recovery units as indicated, according to manufacturer's written instructions.
- C. Install CO2 sensor/control/interlock wiring to variable frequency drives and to ATC system. Install global CO2 sensor to monitor ambient outside air CO2 level.
- D. Install and interlock space CO2 sensors.
- E. Install heat wheels so supply and exhaust flow in opposite directions and rotation is from exhaust side to purge section to supply side.
 - 1. Provide access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
 - 2. Provide removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
- F. Install and interlock outside air flow monitoring station.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- H. Ducts and fan installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- I. Ground Equipment
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- J. After completing system installation, including outlet fittings and devices, inspect and clean exposed finishes. Remove dirt and construction debris and repair damaged finishes.
- K. Startup Services: Engage a factory-authorized service representative to commission units as specified below.
 - 1. Energize and verify correct rotation of heat wheels and fans.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 - 4. Test refrigerant circuit and controls.
 - 5. Record refrigerant pressures.
 - 6. Verify sequence of operation.

7. Record fluid temperatures and flow rates.
 8. Verify and record minimum and maximum air flow rates for the supply and exhaust air fan.
 9. Verify and record the minimum and maximum supply/exhaust fan speeds/ hertz and incorporate into the fan tracking sequence of operation.
 10. Test A/C condensate overflow safety switch.
 11. Test flow switches.
 12. Test hot gas re-heat coil operation.
 13. Verify and record the minimum and maximum supply/exhaust fan speeds/hertz and incorporate into the fan tracking sequence of operation.
- L. Training
1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventative maintenance.
 2. Review data in the operation and maintenance manuals. Refer to Division 01 Section, Demonstration and Training.
 3. Schedule training with Owner, through Architect, with at least 7 days advance notice.

3.17. AIR COOLED CONDENSING UNIT INSTALLATION REQUIREMENTS

- A. Mount outdoor unit as detailed on drawings.
- B. Supply initial charge of refrigerant and oil as required.
- C. Install refrigerant piping between condensing unit and indoor unit per manufacturer's instructions.
- D. Size refrigerant piping in accordance with condensing unit manufacturer's instructions.
- E. Set condensing unit on vibration isolators and level.
- F. Comb out fins on condensing unit where deformed or bent. Replace or repair broken fins.
- G. Coordinate electrical characteristics with equipment supplied.

3.18. HEATING AND VENTILATING UNIT AND MAKE-UP AIR UNIT INSTALLATION REQUIREMENTS

- A. Examine areas and conditions for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of H & V/make-up air units. Do not proceed with installation until unsatisfactory conditions have been

corrected.

- B. Examine piping and electric rough installations for H & V and make-up air units to verify actual locations of piping connections before installation.
- C. Install H & V/make-up air units according to manufacturer's written instructions.
- D. Install units level and plumb, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- E. Piping Connections: Drawings indicate the general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Connect supply and return piping to unit with unions, shutoff valves, control valve, flow meter fittings, and pressure independent control valve.
- F. Duct Connections: Connect supply, return, exhaust and outside air ducts to H & V unit/make-up air units with flexible duct connections. Provide transitions to match unit duct-connection size. Completely seal and insulate where ductwork connects to unit and filter rack.
- G. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- H. Ground equipment.
 - 1. 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. Replace filters used during construction. Seal all return air ducts to filter racks. Seal air tight all filter racks.
- J. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of water-source heat pumps, including piping and electrical connections. Report results in writing.
 - 1. Test and adjust controls and safeties.
 - 2. Replace damaged and malfunctioning controls and equipment.
 - 3. Test and record air flow rates, hot water flow rates, electrical characteristics. Start-up Company and Test and Balance Engineer must both be present during start-up to simultaneously record the above data.
- K. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules related to

- startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals specified in Division 01.
 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
- L. Maintain minimum of 24 inches clear space at unit filter access. Provide manufacturer required clearances for service at ATC control panel, fan section, energy recovery wheel and electrical section.
- M. All H & V units and make-up air units shall be provided with auto-restart in the event of a power outage. Units shall automatically be enabled to re-start when power is restored.
- N. Install and interlock outside air flow monitoring station.
- O. Startup Services: Engage a factory-authorized service representative to commission units as specified below:
1. Energize and verify correct rotation of heat wheels and fans.
 2. Adjust seals and purge.
 3. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 4. Verify sequence of operation.
 5. Record fluid temperatures and flow rates.
 6. Verify and record minimum and maximum air flow rates for the supply and exhaust air fan.
 7. Test hot water coil control valve and freeze protection pump.
- P. Install and interlock air flow monitoring stations.
- Q. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

SECTION 230701 – HVAC INSULATION

PART 1. GENERAL

1.1. REFERENCE

- A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 23 Section, Common Work Results for HVAC.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2. DESCRIPTION

- A. All piping, ductwork, and equipment installed under this Contract shall be covered as specified.

1.3. SCOPE

- A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to all piping, equipment, and duct systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.4. STANDARDS

- A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or use:
 - 1. American Society for Testing of Materials Specifications:
 - a. ASTM C 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation".
 - b. ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation".
 - c. ASTM C 55, "Standard Specification for Mineral Fiber Blanket and Felt Insulation".
 - d. ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Material".
 - e. ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)".
 - f. ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation".
 - g. ASTM C 1136, "Standard Specification for Barrier Material, Vapor, "Type 1 or 2 (Jacket only)".
 - 2. ASHRAE 90.1 "Energy efficient design of new buildings except low-rise residential buildings", latest edition.

3. International Energy Conservation Code, latest edition.
- B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.5. SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers' Association (NAIMA) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. As minimum, all insulation thicknesses shall be as hereinafter specified.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:
 1. American Society for Testing of Materials ASTM E 84
 2. Underwriters' Laboratories, Inc. UL 723
 3. National Fire Protection Association NFPA 255
 4. ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Materials".
- C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.6. QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.
- C. Mockups:
- D. Provide at project site a sample of each type of insulation hereinafter specified. Display insulation in an "installed" condition, showing typical completed pipe, covers, fittings, ductwork and equipment insulation. No insulation shall be applied until these samples have been accepted by the Engineer. Any insulation work which does not conform to the accepted samples will not be acceptable, and shall be removed and re-installed in a manner acceptable to the Engineer at no additional cost to the Owner. Build mockups according to the following requirements, using materials indicated for the completed work.

1. Include the following pipe insulation mockups:
 - a. Exterior aluminum jacketing
 - b. One 10-foot section of NPS 2 inch straight pipe.
 - c. One 90-degree elbow.
 - d. One tee fitting.
 - e. One NPS 2 inch valve.
 - f. Four support hangers, including hanger shield and insert.
 - g. One strainer with removable portion of insulation.
 - h. One reducer.
2. Include the following equipment insulation mockups:
 - a. One small tank or vessel.
 - b. One centrifugal pump.
 - c. One plumbing pump/circulator.
 - d. One freeze protection pump.
3. Include the following duct insulation mockups:
 - a. One 10 foot section of rectangular straight duct.
 - b. One 90 degree square elbow and one 90 degree radius elbow.
 - c. One branch takeoff.
 - d. One transition fitting.
 - e. Four support hangers.
 - f. Exterior duct insulation.
4. Mockups shall include samples of both concealed insulation and exposed insulation.
5. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
6. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
7. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
8. Obtain Engineer approval of mockups before starting insulation application.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
10. Demolish and remove mockups when directed.
11. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.7. DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer in writing for technical assistance.
- D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.8. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. GENERAL

- A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.2. PIPE INSULATION MATERIALS

- A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with "K" rating of .23 at 75 degrees Fahrenheit mean temperature, for service temperatures between -60 degrees Fahrenheit and +450 degrees Fahrenheit with all service poly-encapsulated jacket. Pipe insulation shall be fiberglass ASJMax SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.
- B. Exterior refrigerant pipe insulation shall be Armacell, or approved equal, foam insulation with exterior field applied aluminum jacketing. Interior refrigerant piping shall be Armacell or approved equal foam insulation. Where interior refrigerant piping is exposed also install field applied PVC jacketing.
- C. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Foster 85-20/85-60

or Childers CP-82 (5 gal cans only) adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.

- D. For fittings on all piping, valves and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Cold piping: Apply a tack coat of vapor barrier coating and reinforcing mesh. After ½ hour, apply second coat of same vapor barrier coating, UL labeled, Type C, for cold water piping, Hot piping Type H for hot water piping: Apply tack of breather mastic. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of breather mastic over the reinforcing cloth, working it to a smooth finish.
1. Vapor Barrier Coating: Foster 30-65; Childers CP-34 or Vimasco 749. Permeance shall be 0.03 perms or less at 45 mils dry as test by ASTM E96.
 2. Breather mastic: Foster 46-50; Childers CP-10/11 or Vimasco WC-5
 3. Reinforcing Mesh: Foster Mast a Fab; Childers Chil Glas #10 or Vimasco Elastafab
- E. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.
- F. For piping having a vapor barrier insulation and for all insulated piping requiring supports, hangers and supports shall be installed outside the insulation. Wherever hangers and supports are installed outside the insulation, pipe insulation protecting shields shall be provided. Where insulation is a load bearing material, of sufficient strength to support the weight of the piping, pipe shields one-third the circumference of the insulation and of a length not less than three times the diameter of the insulation (maximum length 24-inches) shall be provided. Insulation of 7-1/4 pound or greater density will be considered as load bearing for pipe sizes up to and including 2-inches. Where insulation is not of sufficient strength to support the weight of the piping, a half section of high density fiberglass or foam inserts, shall be provided. Vapor barrier and finish shall be applied as required to match adjoining insulation. In addition, shields shall be furnished as specified above.
- G. For piping located outside of the building, a corrugated aluminum weatherproof jacketing system shall be provided. This system shall be Micro-Lot ML as manufactured by Manville, Polyweld by Pabco Metals Corp., Childers, or as approved equal, and installed per the manufacturer's recommendations. Where outdoor piping is receiving electric heat tape, the insulation shall be oversized so that the heat tape is not compressed tightly to the pipe. Pipe jacketing shall be corrugated (3/16-inch) deep aluminum, .016-inch thickness of H-14 temper with aluminum strapping of .75-inch width and .020 inch thickness with moisture barrier. Aluminum jacketing elbows shall be smooth, .016-inch thickness and 1100 alloy. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Longitudinal joints shall be applied so they will shed water and shall be sealed completely with metal jacketing sealant. Sealant shall be Foster

95-44 or Childers CP-76. Circumferential joints shall be closed using preformed butt strips following manufacturer's recommendations for securement. Jacket seams shall be located on the bottom side of the horizontal piping.

- H. On cold systems such as refrigerant piping and cooling coil drain piping, etc. vapor barrier performance is extremely important. All penetrations and seams of the ASJ and exposed ends of insulation must be sealed with vapor barrier coating. The ASJ must be protected with either a coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion. Vapor Barrier Coating: Foster 30-65; Childers CP-34 or Vimasco 749. Permeance shall be 0.03 perms or less at 45 mils dry as test by ASTM E96.
- I. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape solvent weld adhesive and appropriate fasteners.
 - 1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvac jacket with ends that secure to adjacent piping.
 - 2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
 - 3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation. Install oversized hangers to prevent penetrations of pipe insulation vapor barrier.
- J. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.
 - 1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hangers saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.
 - 2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating

at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam or wood blocks with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding +_200 degrees F (93 degrees C), Owens-Corning Pink Calcium Silicate, IIG, or approved equal pipe insulation shall be used for high density inserts.

3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).
4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
6. On vertical runs, insulation support rings shall be used.

2.3. PIPING INSULATION THICKNESSES SCHEDULE

- A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	THICKNESS
All Branch Runouts to Unit Heaters	1-inch thickness
Heating Hot Water Piping 2-inches & Larger	2 -inch thickness
Heating Hot Water Piping 1-½ -inches & Smaller	1 ½ -inch thickness
All Drain Piping from Cooling Coils/Evaporators	1-inch thickness
Chemical Feed System	inch thickness
All Above Grade Floor Drain Piping Serving AHU Condensate Drains include Drain Sumps and Auxiliary Drain Pipes from Auxiliary Pans	1-inch thickness
All Refrigerant Piping	1-inch thickness
Pumped Condensate Piping	1-inch thickness

2.4. EQUIPMENT INSULATION MATERIALS AND THICKNESSES

- A. The following equipment shall be insulated with Fiberglass Rigid Board Insulation or Foam Plastic Insulation:
1. Hot Water Pump Bodies.
 2. Air Separators.

3. Expansion Tanks.
 4. Chemical Feed Tanks.
 5. Hot Water Storage Tanks.
 6. Freeze Protection Pump Bodies.
 7. All Pump Volutes and Strainers.
- B. Insulation for cold surfaces shall be 1-1/2-inch thickness, 6 lb. density, 705 FRK with a "K" rating of .23 at 75 degrees F mean temperature. Insulation for hot surfaces except as otherwise noted shall be 1-1/2-inch thickness, 6 lb. density, 705 with a "K" rating of .23 at 75 degrees F mean temperature. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be 1-inch by 25 gauge galvanized steel spaced on not over 12-inch centers. All joints and voids shall be filled with Owens-Corning #110 cement, well troweled into openings. For 705 FRK insulation, all joints and voids shall be FRK taped and vapor sealed. There shall be applied over the insulation surface 1-inch galvanized wire netting laced together at all edges and wired to the steel bands with 16 gauge soft annealed wire. Over this shall be applied 2-inch thick layer of Owens-Corning #110 cement applied in two layers. Install metal corner beads at all corners and edges in order to provide a permanent installation. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 or Childers CP-50AMV1 lagging adhesive at the rate of 60-70 square feet per gallon. Embed into wet coating a layer of 8 ounce canvas or fiberglass lattice mesh smoothed out to avoid wrinkles and lap all seams a minimum of 2-inches. Apply a second brush coat of Sealfas 30-36 or Childers CP-50AMV1 lagging adhesive to the entire surface at the rate of 60-70 square feet per gallon. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from aluminum at least 0.040 inch (1.0 mm) thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- D. Boards shall be scored to allow them to conform to curved or irregular surfaces.
- E. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.
- F. Support rings shall be provided to support the top head insulation where required.

- G. Outdoor installations require a weather barrier for protection of the insulation jacketing.
- H. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

2.5. DUCTWORK INSULATION MATERIALS AND THICKNESSES

- A. Insulate all supply, return, relief, combustion air, plenums, exhaust, and outside air intake ductwork with fiberglass exterior duct insulation with factory-applied foil facing. All exposed fiberglass duct insulation shall be 2-inch rigid or non-flexible board type 3.0 pcf minimum density, 0.23 max. "K" factor at 75 degrees F mean temperature, with white vinyl A.S.J. max, polymer coating vapor barrier facing. All concealed fiberglass duct insulation shall be 2-inch flexible blanket type, 1.0 pcf minimum density. All concealed insulation shall be 0.27 max. "K" factor at 75 degrees F mean temperature with reinforced foil-scrim Kraft vapor barrier facing. Unless otherwise noted, the minimum installed R-value shall be 6.0 HR x ft² x °F/btu.
- B. Refer to Division 23 Section, HVAC Air Distribution System and contract drawings for location of all sound-lined ductwork. Sound-lined ductwork from the discharge or supply side of all air handling units, energy recovery units, make-up air units, and H&V units shall require external insulation in addition to internal lining specified hereinafter. All other ducts indicated to be provided with interior lining shall not require additional exterior insulation.
- C. Where exhaust ducts carrying moisture-laden air such as shower exhaust are routed in unconditioned spaces, insulation is required as described above. Insulation shall be continuous through the unconditioned area. The vapor barrier shall be tightly sealed to prevent condensation. Exhaust ducts located within conditioned spaces do not require insulation unless otherwise noted.
- D. Where a vapor barrier is required, all joints, seams, tears, punctures, and other penetrations shall be closed with 3-inch (7.5cm) pressure-sensitive tape matching the facing or with vapor barrier coating reinforced with 3-inch (7.5cm) glass scrim tape.
- E. Exposed dual wall ductwork located in finished areas shall not require additional exterior insulation. Exposed dual wall supply ductwork located in mechanical room, fan rooms, penthouse, mezzanines and boiler rooms shall require additional rigid exterior insulation as hereinafter specified.
- F. Contractor-applied internal linings shall be as specified and installed as hereinafter specified.
- G. For exposed Fiberglass duct insulation, tightly butt all edges and seams. Secure insulation with flush mechanical fasteners spaced not less than one per square foot. Insulation may be secured with 100 percent coverage of adhesive with mechanical fasteners on the underside of the duct only, in addition to adhesive. Adhesive shall be water based Foster 85-60 or Childers CP-127. Cover all seams, joints and fasteners with not less than 3-inch wide tape matching the insulation facing. Pre-finished white fastener caps may be left exposed if the spacing and pattern is uniform in appearance. Staples will not be permitted.
- H. All dual wall exterior ductwork shall be insulated with 2-inch rigid type 6.0 pcf minimum

density, .25 max "K" factor with white vinyl A.S.J. vapor barrier facing. Insulation shall be sandwiched between inner galvanized ductwork and exterior aluminum ductwork.

- I. All supply air diffusers and supply air registers shall be fully insulated on the rear exposed surface to prevent condensation. Insulation shall be 1 ½" inch flexible blanket type 1 ½ pcf minimum density with reinforced foil-scrim-Kraft vapor barrier facing, .25 max "k" factor.
- J. All airflow monitoring stations shall be externally insulated similar to adjacent ductwork as hereinbefore specified.

2.6. ACCESSORY MATERIALS

- A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:
 - 1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
 - 2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.
 - 3. Support Materials - Hanger straps, hanger rods, saddles.
 - 4. Fasteners, weld pins/studs, speed clips, insulation washers.
 - 5. Metal mesh or expanded metal lagging.
- B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.7. FIELD-APPLIED JACKET

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: High gloss white.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

2.8. HANGER BLOCKS

- A. For all pipes larger than 3 inches in diameter the hanger blocks shall be high compressive strength foam or wood blocks. Wood blocks shall be precision cut thickness to match specified insulation and shall include flared edge hanger saddle as manufactured by Buckaroo.
- B. The wood blocks shall be suitable for temperatures from -120 degrees Fahrenheit to 200 degrees Fahrenheit. Do not utilize the wood blocks for piping systems operating outside of the indicated temperature range.
- C. Wood blocks are not acceptable for use at refrigerant pipe hangers.

PART 3. EXECUTION

3.1. WORKMANSHIP

- A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.2. SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3. PREPARATION

- A. Ensure that all pipe and equipment surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-

applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

- C. Ensure that pressure testing of piping or duct systems has been completed prior to installing insulation.

3.4. INSTALLATION

A. Piping Systems

1. General:

- a. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
- b. Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
- c. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
- d. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures and other penetrations of the pipe insulation vapor barrier coating.
- e. On exposed piping, locate insulation and cover seams in least visible location.

2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:

- a. Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
- b. Cold pipe fittings: Apply a tack coat of vapor barrier coating and reinforcing mesh to produce a smooth surface. After ½ hour, apply a second coat of same vapor barrier coating, UL labeled, Type C, for cold water piping.
- c. Hot pipe fittings and Type H for hot water piping: Apply tack of breather mastic. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of Type C or Type H breather mastic over the reinforcing cloth, working it to a smooth finish.
- d. Insulation cement equal in thickness to the adjoining insulation.
- e. PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

4. Joints:
 - a. Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.
 - b. All pipe insulation ends shall be tapered and sealed, regardless of service.

- B. Equipment Insulation:
 1. General:
 - a. Install insulation in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
 - b. Install insulation on equipment after installation of heat tracing, painting, testing, and acceptance tests.
 - c. Install insulation materials with smooth, even surfaces. Rework poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer installation, applying each layer of insulation separately.
 - d. Coat insulated surfaces where specified on contract drawings with layer of insulating cement, troweled in a workmanlike manner, leaving a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.
 - e. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. Seal all tears, punctures and other penetrations of equipment insulation facing.
 - f. Where specification calls for field-applied all-service vapor barrier jacketing, it shall be neatly fitted and tightly secured. Lap seams 2-inches (5cm) (min.). Seal all joints with adhesive. Tape with 3-inches (7.5cm) matching pressure-sensitive tape or 3-inch (7.5cm) glass fabric and vapor barrier coating.
 - g. On exposed equipment, locate insulation and cover seams in least visible location.

 2. Removable Insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, such as vessel covers, fasteners, flanges, frames accessories, manholes, handholes, cleanouts ASME stamp, and manufacturer nameplates.

 3. Areas Left Uninsulated: Items such as boiler manholes, handholes, clean-outs, ASME stamp, and manufacturers' nameplates should be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, provide removable insulation and appropriate tagging to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

 4. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather barrier mastic protective finish or jacketing as

recommended by the jacketing manufacturer.

C. Ductwork Insulation:

1. General:

- a. Before installing insulation, ensure that all seams and joints in ductwork have been sealed and leak tested by the contractor responsible for the duct system. Before applying duct insulation, air ducts shall be clean and dry.
- b. Install insulation in accordance with manufacturer's published instructions and recognized industry practice to ensure that it will serve its intended purpose.
- c. Install insulation materials with smooth and even surfaces. Butt joints firmly together to ensure complete and tight fit over surfaces to be covered.
- d. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples used on ductwork insulation shall be coated with suitable sealant to maintain vapor barrier integrity and covered with pressure sensitive vapor barrier tape and vapor barrier coating as specified.
- e. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and exposed joints. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.
- f. To ensure installed thermal performance, duct wrap insulation shall be cut to "stretch-out" dimensions. Maintain specified duct insulation thickness and vapor barrier at all fittings, obstructions, and duct flanges.
- g. A 2-inch (50mm) piece of insulation shall be removed from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.
- h. Install duct wrap insulation with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the 2-inch (50mm) stapling and taping flap overlapping. If ducts are rectangular or square, install so insulation is not excessively compressed at corners. Seams shall be stapled approximately 6-inches (150mm) on center with 2-inch (13mm) (min) steel outward clinching staples.
- i. Seams, joints and staples shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) and glass fabric and vapor barrier coating. Cloth duct tape of any color or finish using reclaimed rubber adhesives shall not be utilized on duct wrap insulation. Adjacent sections of duct wrap shall be tightly butted with the 2-inch (50mm) tape flap overlapping.
- j. Where rectangular ducts are 24-inch (600mm) in width or greater, duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-inch (425mm) centers (maximum) to prevent sagging of insulation.
- k. Seal all tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor tight system.
- l. Upon completion of installation of duct wrap and before operation is to commence, visually inspect the system and verify that it has been correctly installed.
- m. Open all system dampers and turn on fans to blow all scraps and other

- loose pieces of material out of the duct system. Allow for a means for removal of such material.
- n. Check the duct system to ensure that there are no air leaks through joints.
 - o. No ductwork insulation shall be supported utilizing tie wire or bailing wire. Penetrations of ductwork insulation vapor barrier are prohibited.
 - p. Bevel and terminate insulation at access doors. Paint edges with vapor barrier mastic.
 - q. Install insulation board between volume dampers and sheet metal standoffs.
 - r. Provide removable insulation section at all pitot tube traverse points. Insulation section shall contain tether that attaches to adjacent ductwork.
2. Penetrations: Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise specified.
3. Ductwork Exposed to Weather: Protect outdoor insulation from weather by installing outdoor weather barrier mastic or jacketing as recommended by the insulation manufacturer.
4. Rigid Insulation:
- a. Rigid duct insulation may be impaled over welded pins and secured with insulation caps and washers matching the color of the vapor barrier facing. All seams shall be firmly butted and sealed with pressure-sensitive vapor barrier tape matching the facing and vapor barrier coating.
 - b. Corner angles shall be installed on all external corners of rigid duct insulation in exposed finished areas before jacketing, except oven and hood exhaust duct insulation, which shall have no corner angles.
5. Duct Wrap Insulation: Duct wrap insulation shall be applied with all joints butted firmly together. All joints in the insulation covering shall be sealed with adhesive. Duct wrap insulation shall be secured to bottom of rectangular or oval ducts over 24inches (60cm) wide with mechanical fasteners on 16-inch (40 cm) (approx.) centers to prevent sagging.
6. Duct Lining Insulation: Duct liner insulation shall be applied with all joints tightly butted using 90 percent coverage of adhesive meeting the requirements of ASTM C 916 plus mechanical fasteners spaced according to the liner manufacturer's schedule for the interior width of the plenum, housing, or air shaft. (Also refer to Division 23 Section, HVAC Air Distribution System.)

3.5. FIELD QUALITY ASSURANCE

- A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.6. PROTECTION

- A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation

with vapor barrier damage and moisture-saturated insulation.

- B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.7. SAFETY PRECAUTIONS

- A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.
- B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.8. INSULATION COVERING

- A. Unless otherwise noted, all exposed duct and equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over ductwork and equipment insulation. PVC shall be high gloss white and shall be 20 mils thick.
- B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, white high gloss, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 20 mils, roll stock ready for shop or field cutting and forming.
- C. Exposed areas include, but are not limited to, all mechanical equipment rooms/fan rooms, mezzanines, penthouses, boiler rooms, kitchens, electric rooms, piping and ductwork exposed in an occupied space.
- D. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Exterior exposed pipe insulation required to be insulated shall be jacketed with a corrugated aluminum jacketing system as previously described. Seal all laps with 1/8" bead metal jacketing sealant.

END OF SECTION

SECTION 230900 - INSTRUMENTATION AND CONTROLS OF HVAC AND PLUMBING SYSTEMS
(DDC SYSTEM)

PART 1. GENERAL

1.1. SUMMARY

- A. For General Mechanical Requirements, see Division 23 Section, Common Work Results for HVAC, and Division 01 Sections.
- B. Comply with all code requirements and fire safety requirements as specified in Division 23 Section, Common Work Results for HVAC.
- C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- D. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory wired controls.
- E. The automatic temperature control system ATC and central control and monitoring system (CCMS) shall be electric/electronic direct digital control (DDC), Alerton, Johnson Controls (Metasys), Johnson Controls FX as installed by Modern Controls, Honeywell, Siemens, Automated Logic Corporation, Reliable Controls, Schneider Electric, Advanced Power, Trane, and TAC Controls by Schneider Electric installed by Automation and Control Concepts or Niagara. All work associated with the automatic temperature control system shall be performed by personnel regularly and directly employed by the Automatic Temperature Controls Contractor. Control System shall be web based, allowing the client access via a standard web browser.
- F. Coordinate controls with controlled equipment. Upon completion of the work, calibrate and adjust all controls for proper function. Electric wiring, including interlock wiring for equipment such as air handlers, fans, switches, ERV's, pumps, variable refrigerant volume systems, H&V units, make-up air units, unit heaters, condensing units, carbon monoxide systems, etc., shall be furnished and installed under this section. All electrical work shall conform to the applicable requirements of Division 26.
- G. All automatic temperature control dampers, valves and separable wells for immersion elements furnished by the Control Manufacturer shall be installed by the Mechanical Contractor or his sheet metal subcontractor under the Control Manufacturer's supervision.
- H. Reference is hereby made for this contractor to become familiar with Division 26 of these specifications. Familiarization is for coordination purposes only. The control contractor shall provide all necessary relays, contacts, interlock wiring etc. not provided under Division 26 for the automation of the ATC and CCMS systems as required by the sequence of operation and input/output schedule. The control contractor shall coordinate all requirements with the building Fire Alarm System. The control contractor shall provide all additional devices and interlock wiring required for the automation of the ATC system and monitoring of the CCMS system.
- I. Furnish all labor, materials, software, equipment and services necessary for and incidental

to furnishing and installing a complete direct digital control, automatic temperature control system to meet the requirements of the sequence of operation described on the Drawings.

- J. Unless the necessary items are specified to be provided with mechanical equipment by Division 23, the ATC contractor shall coordinate with Division 23, Mechanical, and shall furnish and install all items necessary to meet the requirements of the Sequence of Operation and the Central Control and Monitoring System (CCMS) indicated on the drawings and as required in this specification.
- K. The control system shall include all necessary and specified control equipment properly installed in accordance with the specifications and drawings and shall include, but not be limited to the automatic temperature control and energy management system of the following:
1. Air Handling Units, Heating and Ventilating Units
 2. Airflow Monitoring Stations
 3. Building Demand and Energy Consumption
 4. Carbon Monoxide Systems
 5. Carbon Dioxide Sensors
 6. Condensing Units
 7. Differential Pressure Bypass Valves
 8. Domestic Hot Water Systems
 9. Ductless Units
 10. Duct Detector Fan Interlocks
 11. Energy Recovery Ventilators
 12. Exterior Lighting Systems
 13. Flow Measuring Stations
 14. Flow Switches
 15. Carbon Monoxide Exhaust Systems
 16. General Exhaust Systems
 17. Heating System
 18. High Temperature Alarms
 19. Hot Gas Re-heat Coils

20. Industrial Exhaust Fans (Carbon Monoxide)
 21. Lighting Systems (Interior and Exterior)
 22. Make-up Water Systems Interlocks and Alarms
 23. Make-up Air Units
 24. Mechanical Room Heat and Ventilation Control
 25. Miscellaneous interlocks required for gas systems, ventilation systems, etc.
 26. Plumbing Systems
 27. Pumps
 28. Static Pressure Controllers
 29. Unit Heater Control
 30. Variable Speed Drives
 31. Ventilation Systems
 32. Variable Refrigerant Volume Systems
- L. All labor, material, equipment and software to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be included. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the owner.
- M. Where equipment is specified to be provided by equipment manufacturer or where packaged controls are specified map out all points provided by the manufacturer so the same can be viewed by ATC system. As a minimum all points indicated in the point list and control diagram must be viewable and adjustable from the ATC system. Coordinate with equipment manufacturer.

1.2. DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.

- G. RTD: Resistance temperature detector.
- H. UPS: Uninterruptible Power Supply.
- I. NAE: Network Automated Engine.

1.3. SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 2. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 3. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 4. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 5. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 6. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 7. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
 - e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
 - f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
 - g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
 - h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
 - o. Carbon Monoxide: Plus or minus 5 percent of reading.
 - p. Carbon Dioxide: Plus or minus 50 ppm.
 - q. Electrical: Plus or minus 5 percent of reading.

1.4. DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.5. COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section, "Fire Alarm System" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- D. Coordinate equipment with Division 26 Section, Electricity Metering to achieve compatibility of communication interfaces.
- E. Coordinate equipment with Division 26 Section, Panelboards to achieve compatibility with starter coils and annunciation devices.
 - 1. Coordinate equipment with Division 26 Section, Motor-Controllers to achieve compatibility with motor starters and annunciation devices.

1.6. WORK BY OTHERS

- A. Automatic temperature control valves, air flow stations, pipe taps, flow meters, and separable wells for immersion elements furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer's supervision. The control contractor shall deliver to the mechanical contractor valves and wells for installation within the various systems.
- B. All automatic dampers furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer's supervision.

1.7. QUALITY ASSURANCE

- A. The automatic temperature control (ATC) system and the central control and monitoring system (CCMS) shall be as manufactured by Johnson Controls, Johnson Controls FX as installed by Modern Controls, Honeywell, Siebe, Siemens, Alerton, Automated Logic Corporation, Reliable Controls, Schneider Electric, Advanced Power, Trane, shall be an acceptable installer of the ATC system.
- B. Supplier shall have an in-place support facility with technical staff, spare parts inventory and all necessary test and diagnostic equipment. The fully staffed and equipped office shall be within a 60 mile radius of the job site.
- C. The systems shall be complete in all respects, and shall be installed by skilled personnel. The Control Contractor shall have a successful history in the installation and maintenance

of automatic temperature control systems similar in size and performance to that specified herein.

- D. All electrical wiring in connection with the Automatic Temperature Control System shall be furnished and installed by the ATC Contractor. This shall include all interlock wiring between the air handling units, fans, pumps, heating systems, boilers, switches, dampers, energy recovery ventilators, ductless units, condensing units, static pressure controllers, and energy recovery modules, variable refrigerant volume systems, H&V units, etc.
- E. Bids by wholesalers, contractors or franchised dealers or any other firm whose principal business is not that of manufacturing or installing automatic temperature control systems, shall not be acceptable. Bid documents that are not complete in their response to these documents or take exception to any of the capabilities defined within these documents shall not be acceptable.
- F. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- G. 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.
- H. Comply with ASHRAE 135 for DDC system components.

1.8. GUARANTEE AND INSTRUCTION

- A. The control system including all components, system software, parts and assemblies herein specified shall be free from defects in workmanship and materials under normal use and service. After completion of the installation, the Control Manufacturer shall regulate and adjust all thermostats, control valves, control motors, and other equipment provided under this contract. If within two (2) years from the date of acceptance by Owner any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired at no additional cost to the Owner. The Control Manufacturer shall, after completion, provide any service incidental to the proper performance of the Control System under guarantees outlined above for a period of two (2) years. Normal maintenance of the system is not to be considered part of the guarantee. All corrective modifications made during warranty service periods shall be updated on all user documentation including "as-built" shop drawings and on user and manufacturer archived software disks.
- B. The control contractor shall completely check out, calibrate and test all connected hardware to insure that the system performs in accordance with the approved specifications and sequences of operation submitted.
- C. Upon completion of the work, the control drawings encased in heavy plastic shall be provided where directed. Layout shall show all control equipment and the function of each item indicated.
- D. The temperature control contractor's office shall be within a 100 mile radius of the job site.
- E. The contractor shall respond to the job site with qualified technicians within a 4 hour period

for any emergency relating to the control system or energy management systems.

F. This agreement shall include emergency service during normal working hours.

1.9. SUBMITTALS

A. **Product Data:** Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. **DDC System Hardware:** Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. **Control System Software:** Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. **Controlled Systems:** Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing equipment, fans, pumps, coils, dampers, valves, and control devices.
3. **Wiring Diagrams:** Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. **DDC System Hardware:**
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. **Control System Software:** List of color graphics indicating monitored systems,

data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks or Bacnet.
- D. Software and Firmware Operational Documentation: Include the following:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.
- E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- F. Qualification Data: For Installer and manufacturer.
- G. Field quality-control test reports.
- H. Submit screen shots of ATC system graphics at substantial completion.
- I. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section, Operation and Maintenance Data, and Division 23 Section, Common Work Results for HVAC include the following:
 1. Maintenance instructions and lists of spare parts for each type of control device.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and

calibration tolerances.

5. Calibration records and list of set points.

J. Upon completion of the work, provide a complete set of "as-built" drawings and application software on CD, USB, or other type of electronic storage device. Drawings shall be provided in format as acceptable to the Owner's files. Submit as-built drawings and specification to Owner's representative for review and approval prior to final project closeout.

1.10. SOFTWARE LICENSE AGREEMENT

A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. Software license agreement shall not apply on projects where existing ATC system is being extended.

1.11. ELECTRICAL SURGE PROTECTION

A. It is the responsibility of the ATC/FMS contractor to provide adequate surge protection for all wall mounted control panels required for this project.

1. Devices under surge protection shall be of design that loss of memory will not occur in the event of the surge protection device being activated due to surge/spike conditions.

2. Surge protection devices will be required to be hard wired, with the exception of peripheral devices that use standard 110VAC plugs for connections (i.e. Modems).

3. Surge protection devices are to be rated for 120 VAC single phase, 20 (or greater) amps capacity.

4. Surge Protection devices to include internal fuse protection, audible surge alarm & LED indicators.

5. Surge protectors to have clamping voltage of 480V peak, maximum surge current rating of 50,000 amps. Unit to have NEMA 12 enclosure with wall mounting bracket and conduit connection.

1.12. TRAINING

A. The Automatic Temperature Controls (ATC) Contractor shall include in his bid, provisions for additional computer training at the company's regular school or training center. The ATC contractor shall include in his bid all costs associated with sending one (1) individual to the ATC contractors school for a period of not less than two (2) weeks. This training is in addition to the aforementioned training required under the General Provisions.

B. The training time period shall be coordinated with the school system's facility Engineer.

The schedule training period shall be arranged at the owner's convenience.

- C. Cost shall include all training material, instruction books, and two copies of video tape with sound DVD of training session.
- D. Upon completion of the work, the Control Contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on the operation of the control system for a period of not less than [two (2) eight (8) hour days]. All training shall be by the control contractor and shall utilize specified manuals and as-built documentation.
- E. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
 - 3. Review data in maintenance manuals. Refer to Division 01 Section, Contract Closeout.
 - 4. Review data in maintenance manuals. Refer to Division 01 Section, Operation and Maintenance Data.
 - 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

1.13. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

1.14. DELTECH COMMUNITY COLLEGE SPECIFIC REQUIREMENTS

- A. The ATC Subcontractor shall include in his bid all costs associated with incorporating the following specific requirements:
 - 1. All holiday schedules shall incorporate a 12 month block. Coordinate exact holidays, schedules, calendars, occupied, unoccupied periods with Owner prior to writing software. All schedules shall be reviewed and approved by the Owner.
 - 2. Relays for ATC equipment shall not be located in ceilings. All relays shall be located in equipment control panels and/or mechanical rooms.
 - 3. All exhaust fans shall be assigned a designated point. Utilizing relays to provide digital point for exhaust fans shall not be acceptable.
 - 4. Graphics on ATC computer shall in addition to basic requirements indicate the

percentage open or closed on all valves and dampers.

5. The ATC Computer Graphics shall incorporate the final room numbers actually utilized in the Automotive Center. All room names utilized in the graphic display shall be reviewed and approved by the Owner.
6. The ATC Computer Graphics shall indicate for each item of equipment the “on” or “off” status and command shall be “run” or “stop”.
7. The ATC Computer Graphic shall indicate for each duct smoke detector the “on” or “off” status and command.
8. All Temperature Sensors, equipment, humidity sensors, current sensors, CO2 sensors, differential pressure sensors, etc. indicated on ATC Control Diagrams and point list shall be displayed on the ATC Computer Graphic. Measured value or status shall be displayed.
9. For any multi-stage HVAC units, the quantity of compressor stages shall be displayed on the Computer Graphics.
10. The exact space temperature set points, humidity set points, changeover set points, etc., shall be coordinated with Owner prior to final data entry. All items indicated in sequences of Operation as “adjustable” shall be reviewed and approved by Owner prior to implementation of the same.
11. The outside air humidity, outside air CO2, and outside air temperature shall be monitored on ATC system and reported on ATC Computer Graphics. See Floor plans for exact locations.
12. Provide a graphic of all floor plans indicating location of all equipment interlocked with ATC System including all control panels.
13. Graphic shall also indicate area of building served by each item of equipment. Graphics shall indicate all global sensor readings.
14. All equipment shall be labeled with name of equipment, area served, and area location (room name/number).

1.15. GLOBAL SENSORS

A. General

1. Furnish and install global sensors and report the same on the automatic temperature control system.
2. Global sensors shall monitor and trend the following conditions:
 - a. Outside air temperature.
 - b. Outside air humidity.
 - c. Outside air CO2 level.
 - d. Heating supply water temperature.

- e. Heating return water temperature.
- f. All ventilation fan speeds where variable frequency drives are specified.
- g. Outside air carbon dioxide level.
- h. All ventilation fan amperage where variable frequency drives are specified.
- i. All pump or fan speeds where variable frequency drives are specified.
- j. All pump amperage's where variable frequency drives are specified.
- k. All fan amperages where variable speed fans are indicated. Graphic shall also indicate area of building served by each item of equipment.
- l. Main Distribution Frame (MDF), and I.T. server room space temperature sensor.
- m. Global holiday schedules:
 - i. Provide all interlock wiring and programming to allow a global holiday schedule for all equipment except the administration equipment. Global holiday schedule shall allow the Owner to shut down the entire building's HVAC systems if an unscheduled event occurs when college classes are cancelled.
 - ii. System shall also be capable of individual scheduling of equipment as specified or all can be globally modified at once.
- n. All equipment interlocked with ATC system shall be able to be turned on/off via ATC system as specified. Changing temperature set point alone is not acceptable method for turning equipment on/off.
- o. Where valve or damper position is indicated ATC graphic shall indicate percentage open or percentage closed.

PART 2. PRODUCTS

2.1. BUILDING MANAGEMENT SYSTEM

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Building Management System shall consist of the following:
 - 1. Standalone Network Automation Engine(s)
 - 2. Field Equipment Controller(s)
 - 3. Input/Output Module(s)
 - 4. Local Display Device(s)
 - 5. Portable Operator's Terminal(s)
 - 6. Distributed User Interface(s)
 - 7. Network processing, data storage and communications equipment

8. Other components required for a complete and working BMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Acceptable Manufacturers
 1. Johnson Controls, Reliable, Siemens, Honeywell, Automated Logic Cooperation, Schneider Electric, Advanced Power, Trane, Alerton, Niagara, or TAC Controls by Schneider Electric.
- F. Automation Network
 1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
 2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
 3. Network Automation Engines (NAE) and/or system controllers shall reside on the automation network.
 4. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- G. Control Network
 1. Network Automation Engines and/or system controllers shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
 - a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
 - b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
 - c. The Johnson Controls N2 Field Bus or equivalent.
 - d. Tridium FX-40
 - e. Honeywell Webs
 - f. Trend Controls: A division of Honeywell by HavTech Solutions – IQ3
 - g. TAC Controls by Schneider Electric
 - h. Siemens P1/P2 Serial
 2. Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised

Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The Conformance Statements shall be submitted 10 day prior to bidding.

H. Integration

1. Hardwired
 - a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - b. There will be one separate physical point on each system for each point to be integrated between the systems.
2. BACnet Protocol Integration – BACnet
 - a. The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
 - b. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
 - c. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

I. Dedicated Web Based User Interface

1. Where required by the Owner, the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability. Coordinate with Owner to determine computer type (i.e. PC (Windows based) or Macintosh (Apple)).
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance

- c. of reports, sequences other necessary building management functions
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.
3. Computer Hardware – The personal computer(s) shall be configured as follows:
- a. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.
 - b. Performance Requirements:
 - i. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - ii. Energy Star compliant.
 - c. Personal Computer:
 - i. Minimum Processor Speed: 3 gigahertz (GHz).
 - d. RAM:
 - i. Capacity: 8GB.
 - ii. Speed and Type: 1333 MHz, SDRAM.
 - e. Hard Drive:
 - i. Media: Solid state.
 - ii. Number of Hard Drives: One.
 - iii. Capacity: 250GB.
 - f. Optical Read and Write Drive:
 - i. Include with at least 2 MB of data buffer.
 - ii. Type: SCSI CD-ROM Drive with Read/Write Capability.
 - iii. Average access time of 150 ms or less.
 - g. At least four expansion slots.
 - h. Video Card:
 - i. Resolution: 1920 by 1200 pixels.
 - ii. RAM: 4 GB.
 - iii. Controller Speed: 4GHz.
 - i. Sound Card:
 - i. At least 128 voice wavetable synthesis.
 - ii. Capable of delivering three-dimensional sound effects.
 - iii. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
 - j. Network Interface Card: Include card with connection, as applicable.
 - i. 10-100-1000 base TX Ethernet with RJ45 connector port.
 - ii. 100 base FX Ethernet with SC or ST port.
 - k. Wireless Ethernet, 802.11 a/b/g/n.
 - l. Optical Modem: Full duplex link for connection to optical fiber cable provided.
 - m. I/O Ports:
 - i. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
 - ii. One serial port.
 - iii. One parallel port.
 - iv. Two PS/2 ports.
 - v. One RJ-45.

- vi. One stereo line-in and headphone/line-out on back panel.
- vii. One microphone and headphone connector on front panel.
- viii. One IEEE 1394 on front and back panel with PCI-e card.
- ix. One ESATA port on back panel.
- n. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
- o. Keyboard:
 - i. 101 enhanced keyboard.
 - ii. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
 - iii. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
- p. Pointing Device:
 - i. Either a two- or three-button mouse.
 - ii. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
- q. Flat Panel Display Monitor:
 - i. Display:
 - 1. Color display with 21 inches diagonal viewable area.
 - 2. Digital input signal.
 - 3. Aspect Ratio: 16 to 9.
 - 4. Antiglare display.
 - 5. Tilt adjustable base.
 - 6. Energy Star compliant.
 - 7. Resolution: 1920 by 1200 pixels at 60 Hz.
 - 8. Number of Displays: One.
- r. Speakers:
 - i. Two, with individual controls for volume, bass and treble.
 - ii. Signal to Noise Ratio: At least 65 dB.
 - iii. Power: At least 4 W per speaker/channel.
 - iv. Magnetic shielding to prevent distortion on the video monitor.
- s. I/O Cabling: Include applicable cabling to connect I/O devices.

J. User Interface Application Components

1. Operator Interface

- a. An integrated browser based client application shall be used as the user operator interface program.
- b. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3 or on the drawings, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
- c. The user interface software shall provide help menus and instructions for each operation and/or application.
- d. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- e. The Operator Interface shall incorporate comprehensive support for

functions including, but not necessarily limited to, the following:

- i. User access for selective information retrieval and control command execution
- ii. Monitoring and reporting
- iii. Alarm, non-normal, and return to normal condition annunciation
- iv. Selective operator override and other control actions
- v. Information archiving, manipulation, formatting, display and reporting
- vi. FMS internal performance supervision and diagnostics
- vii. On-line access to user HELP menus
- viii. On-line access to current FMS as-built records and documentation
- ix. Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
- x. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. Navigation Trees

- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
- b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
- c. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. Alarms

- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - i. Log date and time of alarm occurrence.
 - ii. Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
 - iii. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - iv. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken

- on the alarm, and a time/date stamp.
 - v. Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - vi. Any attribute of any object in the system may be designated to report an alarm.
 - b. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
 - c. The FMS shall annunciate application alarms as required.
- 4. Reports and Summaries
 - a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - i. All points in the BMS
 - ii. All points in each BMS application
 - iii. All points in a specific controller
 - iv. All points in a user-defined group of points
 - v. All points currently in alarm
 - vi. All points locked out
 - vii. All BMS schedules
 - viii. All user defined and adjustable variables, schedules, interlocks and the like.
 - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
 - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
 - d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
- 5. Schedules
 - a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - i. Weekly schedules
 - ii. Exception Schedules
 - iii. Monthly calendars
 - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
 - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
 - d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

- e. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
 - f. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
 - g. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
6. Password
- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
 - b. Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
 - c. The system shall allow each user to change his or her password at will.
 - d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - e. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - i. Level 1 = View Data
 - ii. Level 2 = Command
 - iii. Level 3 = Operator Overrides
 - iv. Level 4 = Database Modification
 - v. Level 5 = Database Configuration
 - vi. Level 6 = All privileges, including Password Add/Modify
 - f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
7. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
8. Dynamic Color Graphics
- a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
 - b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and

- executed.
 - c. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
 - d. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - i. All graphics shall be fully scalable
 - ii. The graphics shall support a maintained aspect ratio.
 - iii. Multiple fonts shall be supported.
 - iv. Unique background shall be assignable on a per graphic basis.
 - v. The color of all animations and values on displays shall indicate the status of the object attribute.
 - e. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - f. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - i. The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - ii. In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - g. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
9. Historical trending and data collection
- a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - i. Any point, physical or calculated, may be designated for trending. Two (2) methods of collection shall be allowed:
 - 1. Defined time interval
 - 2. Upon a change of value.
 - ii. Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
 - b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

10. Trend data viewing and analysis
 - a. Provide a trend viewing utility that shall have access to all database points.
 - b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
 - c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
 - d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
 - e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
 - f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
 - g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

K. Network Automation Engine (NAE)/ System Controllers

1. The Network Automation Engine (NAE)/ System Controllers or approved equal shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support up four (4) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

- i. Configuration
 - ii. Commissioning
 - iii. Data Archiving
 - iv. Monitoring
 - v. Commanding
 - vi. System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus – Normal Communications/No Field Communications
 - e. Peer Communication – Data Traffic Between NAE Devices
 - f. Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running
 - g. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - h. Fault – General Fault
 - i. Modem RX – NAE Modem Receiving Data
 - j. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
 - a. Up to two (2) USB port
 - b. Up to two (2) URS-232 serial data communication port
 - c. Up to two (2) RS-485 port
 - d. One (1) Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to

establish communication.

10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
 - a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - i. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
 - ii. The Conformance Statements shall be submitted 10 day prior to bidding.
 - iii. The NAE shall support a minimum of 100 control devices.
 - b. The NAE shall support the Johnson Controls N2, Tridium FX-40, or Honeywell Webs or approved equal Field Bus.
 - i. The NAE shall support a minimum of 100 N2 control devices.
 - ii. The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - iii. The Bus shall employ a master/slave protocol where the NAE is the master.
 - iv. The Bus shall employ a four (4) level priority system for polling frequency.
 - v. The Bus shall be optically isolated from the NAE.
 - vi. The Bus shall support the Metasys Integrator System.

2.2. WIRING

- A. The multi-conductor cable for field wiring of electronic analog sensors shall be minimum No. 22 AWG, 300 volt, thermoplastic with stranded copper wire and 100 percent shield coverage. The number of conductors in each sensor cable shall be as determined by the Contractor. 2/c #22 shielded cables shall be Belden Cat. #8451 3/c #20 shielded cables shall be Belden Cat. #9770 or approved equal.
- B. Conductors for digital sensors or contact control shall be the same as for the analog sensors, except the grounded shield is not required.
- C. Individual conductors shall be color coded and in addition shall be numbered in the field

to identify the particular terminal to which attached. Field numbering shall be performed with Brady or approved equal markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material and terminal connection.

- D. All exposed wiring or wiring concealed in partitions shall be installed in a designated conduit raceway. The conduit shall conform to Division 26 of the specification. Where wiring is installed in an air plenum the same shall be plenum rated cable.
- E. All junction boxes shall have covers painted safety green, and be rigid steel.
- F. All wiring between differential pressure transmitters and variable frequency drive pump controllers shall be shielded and grounded at the pump controller end. Directly route the variable frequency drive pump controller to the differential pressure transmitter(s).
- G. All wiring between static pressure controllers and/or air flow monitoring stations and variable frequency drive fan controllers shall be shielded and grounded at the fan controller end. Directly route the variable frequency drive fan controller to the static pressure controller(s) and/or air flow monitoring stations.
- H. All control wiring between VRV compressor units, branch selector boxes, and indoor VRV units shall be shielded and grounded per VRV manufacturer requirements.

2.3. CONTROLLERS

- A. Temperature, humidity, and CO2 sensor covers shall be stainless steel wire guard type with vandal proof screws. All room humidity, CO2, and temperature sensors shall be mounted 4'-0 inches above the finished floor, except in stairways, corridors and toilets, which shall be 7'-0 inches. Provide insulating bases where temperature sensors are located on exterior or unconditioned walls. Each temperature sensor shall have adjustable limit stops and adjustable sensitivity. User adjustment shall be 2 degrees F above and below set points or as determined by the Owner. Room temperature sensors shall include range of 55 degrees F to 85 degrees F set point adjustment. Temperature sensors shall include set-point adjusters, U.L. approved for mounting base in air plenums, and RJ-11 jack for communications. Room temperature sensors shall be fully adjustable and shall display set point and actual temperature.
- B. Low Limit Thermostats: Freezestats shall have a minimum 20 foot (averaging sensing element) capillary tube sized to the basis of one linear foot of capillary tube for each square foot of coil surface. Thermostat sensitivity shall be adjustable. Freezestats shall stop supply and return fans and close the outside air damper if mixed air temperature drops below 35 degrees F and open hot water heating valves. Additional requirements are indicated in Sequence of Operation.
- C. Room temperature sensors shall be accessible to ADA occupants.

2.4. DAMPERS

- A. Control Dampers
 - 1. The temperature control contractor shall provide all automatic control dampers of

the types indicated on the plans and not specified to be integral with other equipment. Frames shall be not less than 16 gauge galvanized steel. Blades shall not be over 6 inches wide airfoil shaped double skin construction of 14 gauge equivalent thickness. Bearings shall be stainless steel sleeves with 2 inch shafts. Blade edge seals shall be vinyl blade with flexible metal compressible jamb seals of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 250 degrees F.

2. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade type.
3. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6 inches.
4. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submittal. Maximum leakage shall be 3 CFM/Sq. Ft. at static pressure of 1 inch W.C. for a damper width of 48 inches.
5. Ultra-low leakage dampers shall have blade edges shall to be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 2 percent at applied static pressure.
6. Medium and Low pressure rectangular control dampers shall be Type CD60 airfoil low leakage damper as manufactured by Ruskin or as approved equal of American Warming and Ventilating, Air Balance and Arrow.
7. Round control dampers shall be Type CERS25 with blade edge seals as manufactured by Ruskin or as approved equal.
8. Provide damper end switch for all control dampers where indicated. Damper end switch shall be independent of the damper actuator and shall provide "proof of open" prior to allowing fan to energize. Damper end switch shall be Model TS-475 Mechanical Damper Arm Switch (no-mercury) as manufactured by MDI, Inc. or approved equal. Install per manufacturer's recommendations on control damper. End switch shall have the following features:
 - a. Housing Material: Glass filled PBT (polybutylene terephthalate).
 - b. Bracket Material: Plated steel.
 - c. Operation: Steel ball actuated sub-miniature snap action switch.
 - d. Operating angle: 15 degrees. (Contact closes at 10 degrees above horizontal and contact opens at 5 degrees below horizontal).

B. Smoke Detectors

1. Smoke detectors shall be provided by the Electrical Contractor and installed by the Mechanical Contractor. All wiring, interlocks, etc., to be provided by Electrical Contractor. Wiring from duct smoke detectors to fans shall be by ATC Contractor. Duct smoke detectors shall be tested by the Test and Balance Engineer as specified in Division 23 Section, Testing Adjusting & Balancing for HVAC and Plumbing.

C. Damper Operators

1. Electric damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range.
2. Use devices which are quiet in operation and which in the event of power failure, will "fail safe" by spring action in either the normally open or normally closed position as required for freeze, moisture, smoke, or fire protection.
3. Electric actuators requiring a 24 VAC power supply will be utilized. Motors shall be specifically designed and sized with proper torque according to requirements of the device it is to be used on (i.e.: valve, damper). Each actuator will accept the proper control input as the system is designed, (i.e.: floating, 0-10VDC, 4-20Ma etc.) without the need for any additional interface devices.
4. For all exterior damper operators provide NEMA 4X stainless steel corrosion resistant enclosure. Damper operator enclosure shall be model ZS-300 as manufactured by Belimo or approved equal.

2.5. PRESSURE INDEPENDENT HYDRONIC CONTROL VALVES

A. All automatic control valves 2 inches and smaller shall be screwed type, and valves 2 ½ inches and larger shall be flanged. Valves shall be factory-rated to withstand the pressures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable seats and discs. All control valves must be capable of withstanding the shut-off head of the pumps, they are connected to without the valve seat lifting. Valves shall have stainless steel stems and spring loaded Teflon packing with replaceable seats and discs.

1. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs and shall be pressure independent type. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position modulating. Valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs. Pressure independent control valves shall be as manufactured by Griswold, Delta P, Warren Controls, Danfos, Bray, or approved equal.
2. Pressure Independent Actuated Ball Valves (PIC-V) for Flows up to 85 GPM
 - a. The modulating control valves shall be pressure independent.
 - b. Valves shall accurately control flow within +/-5% (including manufacturing tolerance) independent of system pressure fluctuation by maintaining a constant pressure differential across the control valve so that the valve only repositions on a change in load demand.
 - c. The pressure independent modulating control valve shall include a Pressure Compensating Cartridge, Actuated Ball Valve, 2 PT's, Manual Air Vent, Union, and Manual Isolation Ball in a single valve housing.
 - d. The valve shall have an accuracy of +/- 5% including manufacturing tolerances and pressure variations.
 - e. Valve housing shall consist of forged brass, rated at no less than 360 psi

- at 250°F.
- f. Valve shall include a venturi metering station so that the flow rate can be read by means of differential pressure. Venturi metering station shall not require any straight runs of piping before or after meter.
 - g. Both the ATC and shutoff valve shall have stems that are field repairable with the valve in the line. The body design shall allow inspection or repair of the stem without disturbing piping connections or draining water. The repairable stem shall include two Teflon seals and one EPDM O-ring for protection against chemicals and modulating temperature.
 - h. Valve shall have a union end connection with factory installed air vent to allow for venting of the coil or heat pump.
 - i. The control valve shall accurately control the flow from 0 to 100% full rated flow.
 - j. The ATC portion of the valve shall use the full 90 degrees of the stroke for control. Stroke limiting of the valve shall not be acceptable.
 - k. A flow tag shall be furnished with each valve.
 - l. A universal mounting plate shall allow installation of actuators meeting the system electrical requirements and valve torque requirements as provided by Honeywell, Invensys, Johnson Controls, KMC, Schneider, Neptonic, or Siemens.
 - m. The actuator and plate can be rotated after mounting.
 - n. The actuator mounting assembly shall accommodate no less than 1 ½" of insulation.
 - o. Pressure Compensating Cartridge (PCC)
 - i. PCC shall automatically compensate for pressure changes in valve and shall maintain a constant pressure drop across the flow limiting actuated ball.
 - ii. The operating pressure range shall be available with the minimum range requiring 3 PSID to actuate the cartridge and the maximum 8 psid to actuate the cartridge
 - iii. Valve internal control mechanism includes a diaphragm and full travel linear coil spring.
 - iv. Valves shall include an accessible/ replaceable cartridge.
 - v. Dual pressure/temperature test valves for verifying the pressure differential across the cartridge and flow limiting ball shall be standard.
 - p. Actuated Ball Valve
 - i. Valve ball shall consist of chemically plated nickel brass or stainless steel.
 - ii. Actuator stem shall be removable/ replaceable without removing valve from line.
 - iii. Manufacturer shall be able to provide ball insert to limit flow to maximum flow rate with ±5% accuracy. Insert shall be constructed of a Glass-Filled Polymer. The insert shall be press fit to the inside of the ball. Clipping the insert onto the exiting side of the ball shall not be acceptable.
 - iv. Each maximum flow rate selected shall use a different characterizing disc so that stroke limiting is not required.
 - v. Valve shall have a minimum rangeability as follows: ½"-40:1, ¾"-160:1, 1" to 3"-400:1
 - vi. Valve shall have EPDM O-rings behind Reinforced Teflon

- (PTFE) ball seals.
 - vii. The valve shall have a minimum close-off pressure differential rating of 100 psi with 35 in-lbs of torque for 1/2" to 2" sizes.
 - viii. Actuator shall provide minimum torque required for full valve shutoff position.
 - q. Isolation Ball Valve
 - i. Valve shall include a 600 WOG manual isolation ball valve.
 - ii. Stem shall be removable/replaceable with the valve in the line.
 - r. The control valve actuator will be furnished by the controls contractor under Section 230900.
 - s. Pressure independent valves shall come as one complete assembly from Griswold Controls or approved equal and shall include a supply side combination shutoff/ strainer valve.
- 3. MVP Pressure Independent Control Valves for Flows above 85 GPM.
 - a. Pressure Independent Flow Control Valve 2.5" and Larger
 - i. The modulating control valves shall be pressure independent.
 - ii. Valve shall accurately control flow within +/-5% (including manufacturing tolerance) independent of system pressure fluctuation by maintaining a constant pressure differential across the control valve so that the valve only repositions on a change in load demand.
 - iii. Contactor shall install pressure independent flow control valves where indicated in drawings.
 - iv. Valve shall be electronic, pressure independent, modulating 2-way control device.
 - v. Balancing valves shall not be required where pressure-independent valves are installed.
 - vi. Install flow measuring station and shut-off valve on return pipe to measure flow rate in gallons per minute.
 - b. Valve Actuator
 - i. Valve actuator housing shall be rated to IP44 insulation.
 - ii. Actuator shall be driven by a 24Vdc motor, and shall accept 2-10 Vdc, 4-20mA, 3-point floating or pulse width modulation electric signal and shall include resistor to facilitate any of these signals.
 - iii. Actuator shall be capable of providing 4-20mA or 2-10 Vdc feedback signal to the control system so that the gpm can be determined.
 - iv. External LED readout of current valve position and maximum valve position setting shall be standard.
 - v. Maximum flow setting shall be adjustable to 51 different settings within the range of the valve size by changing the settings electronically on the actuator.
 - vi. Optional fail safe system to power valve to either open or closed position from any position in case of power failure shall be provided per the sequence of operations and the automatic temperature control diagrams.
 - c. Valve Housing
 - i. 2.5"-6": Housing shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 580 psi static

- pressure and 248°C.
- d. Pressure Regulation Unit
 - i. Pressure regulation unit shall consist of 304 Stainless Steel and hydrogenated acrylonitrile butadiene rubber (1/2"-1-1/2") or 316 Stainless Steel and EPDM (2"-6").
 - ii. Flow regulation unit shall be accessible for maintenance without disturbing the piping.
 - iii. Valve shall have a maximum of 8.6 psid to actuate the pressure regulating cartridge.
 - iv. Dual pressure/temperature test valves for verifying accuracy of flow performance shall be available for all valve sizes.
 4. Optional accessories shall include a stem packing lubricator for factory or field assembly. Valve stem packing shall be low friction, tight sealing Teflon.
 5. Unitary valves shall be straight-through or three way type as specified in the sequence of operation with high-pressure connections suitable for copper pipe and rated for 250 psig. Stems shall be polished stainless-steel and packing shall be ethylene-propylene suitable for both chilled water and 250 degree hot water service. Straight-through valves shall have back-seating feature, to allow packing to be replaced without draining system.
 6. All valves shall use guided valve plugs for good seating and reliable operation. Valves 1/2 inch to 1 inch shall be ANSI Class 125 brass body with screwed ends. Valves 1-1/4 inches to 2 inches shall be ANSI Class 150 brass body with screwed ends. Valves 2-1/2 inches to 4 inches shall be Class 125 cast iron body with bronze trim and flanged ends. Valves 6 inches and larger shall be Class 125 steel body with bronze trim and flanged ends. Butterfly valves shall be DeZurick HIGH performance or Keystone Keylock, Lug style as specified in Division 23 Section, HVAC Piping, Fittings, and Valves.
 7. All heating coil valves shall be normally open to the coil.
- B. Control Valve Operators
1. Electric valve actuators shall be properly sized to provide sufficient torque to position valves throughout its operating range.
 2. Use devices which are quiet in operation and which in the event of power failure, will "fail safe" by spring action in either the normally open or normally closed position as required for freeze, moisture, smoke, or fire protection. Spring return valves are required for all control valves where coils are exposed to outside air conditions.
 3. Electric actuators requiring a 24VAC power supply will be utilized. Motors shall be specifically designed and sized with proper torque according to requirements of the device it is to be used on (i.e: valve, damper). Each actuator will accept the proper control input as the system is designed, (i.e.: floating, 0-10VDC, 4-10Ma etc.) without the need for any additional interface devices.

2.6. CONTROL PANELS

- A. Furnish and install local panels for ATC devices. Control panels shall be fully enclosed cabinets, all steel construction and shall meet the requirements of NEMA 1 enclosures. Cabinet shall have piano hinged door with a locking latch. All cabinet locks shall use common key. Provide means of storing control system instructions and drawings inside cabinet for future reference. Panel shall be wall mounted or free standing and located where directed by the Contract Drawings or Engineer.
 - 1. Each panel shall have all internal devices factory wired to a numbered terminal strip. Controllers and associated devices shall be mounted within the panel, accessible through a hinged door.
 - 2. All ATC panels shall be provided with integral disconnect, wiring, and control transformers.
 - 3. Any ATC control panel that is serving equipment on the emergency generator must be powered by an emergency generator fed circuit/electrical panel. Refer to electrical contract documents for all emergency powered equipment.

2.7. MISCELLANEOUS ELECTRICAL DEVICES

- A. Electric Actuators. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators which shall be sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close off as specified.
- B. Aquastats shall be line voltage strap on type with single pole, single throw switching. Switches shall have an adequate rating for the applied load. All wiring from aquastats to domestic recirculating pumps shall be by ATC contractor.

2.8. UNINTERRUPTIBLE POWER SUPPLY

- A. Furnish, size and install uninterruptible power supplies (UPS's) at all ATC panels.
- B. Provide all interlock and power wiring from U.P.S. to control panels as required such that all components are powered via the UPS. For hard-wired equipment furnished with pigtails/wire leads, e.g. control power transformers, splice pigtails/wire leads in junction box to a flexible cord with NEMA 5-15P Plug, which shall be plugged into the UPS.
- C. UPS's shall be sized for the ATC panel load and shall provide at least 10 minutes of full load power in the event of a power outage.
- D. UPS shall be furnished with plug and cord and shall be powered from power receptacle(s) in ATC panels.

2.9. DESKTOP WORKSTATIONS

- A. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.
- B. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
- C. Personal Computer:
 1. Minimum Processor Speed: 3 gigahertz (GHz).
 2. RAM:
 - a. Capacity: 8GB.
 - b. Speed and Type: 1333 MHz, SDRAM.
 3. Hard Drive:
 - a. Media: Solid state.
 - b. Number of Hard Drives: One.
 - c. Capacity: 250GB.
 4. Optical Read and Write Drive:
 - a. Include with at least 2 MB of data buffer.
 - b. Type: SCSI CD-ROM Drive with Read/Write Capability.
 - c. Average access time of 150 ms or less.
 5. At least four expansion slots.
 6. Video Card:
 - a. Resolution: 1920 by 1200 pixels.
 - b. RAM: 4 GB.
 - c. Controller Speed: 4GHz.
 7. Sound Card:
 - a. At least 128 voice wavetable synthesis.
 - b. Capable of delivering three-dimensional sound effects.
 - c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
 8. Network Interface Card: Include card with connection, as applicable.
 - a. 10-100-1000 base TX Ethernet with RJ45 connector port.
 - b. 100 base FX Ethernet with SC or ST port.
- D. Wireless Ethernet, 802.11 a/b/g/n.
 1. Optical Modem: Full duplex link for connection to optical fiber cable provided.
 2. I/O Ports:

- a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
 - b. One serial port.
 - c. One parallel port.
 - d. Two PS/2 ports.
 - e. One RJ-45.
 - f. One stereo line-in and headphone/line-out on back panel.
 - g. One microphone and headphone connector on front panel.
 - h. One IEEE 1394 on front and back panel with PCI-e card.
 - i. One ESATA port on back panel.
3. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
- E. Keyboard:
1. 101 enhanced keyboard.
 2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
 3. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
- F. Pointing Device:
1. Either a two- or three-button mouse.
 2. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
- G. Flat Panel Display Monitor:
1. Display:
 - a. Color display with 21 inches diagonal viewable area.
 - b. Digital input signal.
 - c. Aspect Ratio: 16 to 9.
 - d. Antiglare display.
 - e. Tilt adjustable base.
 - f. Energy Star compliant.
 - g. Resolution: 1920 by 1200 pixels at 60 Hz.
 - h. Number of Displays: One.
- H. Speakers:
1. Two, with individual controls for volume, bass and treble.
 2. Signal to Noise Ratio: At least 65 dB.
 3. Power: At least 4 W per speaker/channel.
 4. Magnetic shielding to prevent distortion on the video monitor.

- I. I/O Cabling: Include applicable cabling to connect I/O devices.
- 2.10. CENTRAL CONTROL AND MONITORING SYSTEM (CCMS) (HARDWARE DESCRIPTION)

A. General

1. The Facilities Management Control System (FMCS) shall be comprised of a network of various independent, Stand-alone Digital Controllers (SDC'S), Mechanical System Digital Controllers (MSDC's), Air Handler Digital Controllers (AHDC's), Unitary Digital Controllers (UDC's); together with Centralized Control Stations (CCS), and Centralized Host Stations (CHS) as specified, to provide centralized access and facility wide control functions. The SDC's, MSDC's, AHDC's, and UDC's shall be interconnected in a communicating network to provide facility wide access and sharing of information. A Gateway Digital Controller (GDC's) shall be provided to allow interface with third party microprocessor based control systems that are specified for integration within specification. A Local Area Network (LAN) shall be provided to interconnect SDC's for high-speed data transmission.

2. Specification Nomenclature

a.	FMCS	Facility Management Control System
b.	SDC	Stand-alone Digital Controller
c.	MSDC	Mechanical System Digital Controller
d.	AHDC	Air Handler Digital Controller
e.	UDC	Unitary Digital Controller
f.	HHOT	Hand Held Operator Terminal
g.	GDC	Gateway Digital Controller
h.	GP	Graphical Programmer
i.	CHS	Central Host Station
j.	CCS	Central Control Station
k.	RPTR	Communications Repeater

B. Centralized Host Stations (CHS)

1. The FMCS shall include Centralized Host Stations. CHS's shall, in conjunction with the full compliment of Digital Controllers, provide the performance requirements within this specification. Each CHS shall include all hardware and software components to serve as a centralized facility operator station, providing color graphics, facility wide access, operator initiation of global control strategies, and centralized documentation.

The CHS shall be capable of simultaneously interfacing with the following:

- a. -mouse pointing device
- b. -two parallel printers
- c. -high resolution VGA color graphics monitor
- d. -seven auto answer/auto dial modems
- e. -color inkjet printer
- f. -two serial printers

- g. -three FMCS LAN interface
- h. -Alarm Graphic and Report FAX dial out service interface
- i. -Mass storage tape system

As a minimum, the temperature control contractor shall provide the types and quantities of CHS, CCS, SDC, MSDC, AHDC, GDC, and UDC, as required.

2. Computer

- a. The existing FMS computer located in the Maintenance Office shall be utilized with the new CCMS System if compatible with the same. If the selected ATC contractor cannot tie into the existing computer, then a new stand-alone computer shall be furnished.
- b. The existing FMS computer located in the Colleges Central Maintenance Office shall be utilized with the new CCMS System. Provide modem terminal, and wiring as required to interface this buildings CCMS system with FMS computer. I/P data drop shall be provided adjacent to the network panels.
- c. Coordinate IP address with Owners' I.T. Department for network connection. The CCMS must be fully networkable.
- d. Provide fiber optic cable as required.

3. Operator Workstation: One PC-based microcomputer with minimum configuration as follows:

- a. Uninterruptible Power Supply: 2 kVa.
- b. Operating System: Microsoft Windows – Latest Version.
 - i. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 - ii. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- c. Printer: Color, ink-jet type as follows:
 - i. Print Head: 4800 x 1200 dpi optimized color resolution.
 - ii. Paper Handling: Minimum of 100 sheets.
 - iii. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

C. Centralized Control Stations (CCS)

- 1. The FMCS shall include Centralized Control Stations, as required. CCS's shall, in conjunction with the network of SDC's and additional CCS components as required, provide the performance requirements within this section of the specification. Each CCS shall include all hardware and software components to serve as a centralized facility operator station, providing facility wide access, for review and modification of global control strategies, real time system monitoring, controller database editing or creation, and centralized documentation.

D. Local Area Networks

- 1. The LAN shall utilize packetized transmissions, CRC 16 error checking, and

distributed error recovery. Single or multiple SDC failures shall not cause loss of communication between other LAN-connected SDC's.

2. LAN connected SDC's shall be provided with a communications watchdog to assure that an individual SDC cannot permanently occupy the LAN. If an SDC is determined to be monopolizing communications, it shall be automatically shut down and an exception reported to annunciate this fact.
3. The LAN shall employ a token passing, peer-to-peer convention, same as or similar to the industry standard format IEEE 802.4. The content of messages shall be the manufacturer's standard. The Local Area Network components shall be manufacturer's standard or available from third party vendors which utilize the same chip implementation as used by the manufacturer.
4. Industry standard ANSI, RS-485 Network Communication System, Lon, or Bacnet, or Equivalent shall be utilized.
5. Trunk Wiring Practices - General

- a. The distributed communication network system shall consist of a multi-drop RS-485 bus architecture connecting SDC's, MSDC's, AHDC's, GDC's, and UDC's. The trunk shall consist of:
 - i. A twisted pair of wires (24 awg) completely encased in continuous metallic conduit.
 - ii. A twisted shielded pair of wires (24awg) with the shield grounded in accordance with the manufacturer's wiring practices.
 - iii. Or a dual channel, 62.5 micron fiber cabling system with ST type connectors.

There shall be no power wiring, in excess of 30 VAC rms voltage, run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communications trunk wiring and power wiring shall be run using separate twisted shielded pairs (24awg) with the shields grounded in accordance with the manufacturer's wiring practices.

- b. Communication Transient Protection
 - i. The manufacturer's catalog data sheet shall provide evidence that all FMCS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.
 - ii. In addition, at each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General semiconductor, Model #422E device. Transient surge protection is not necessary if the communication trunk, external to the building, is fiber optic in nature.

- iii. The communications circuitry and input/output circuitry, of the SDC's, MSDC's, and AHDC's, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMCS controller. Protection shall be provided for the individual communications and input/output terminations for each FMCS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.
- c. **RS-485 Trunk Distance and Topology**
The manufacturer's RS-485 trunk shall provide operation over end to end linear distances of 4000 feet for wire connections and 6,500 feet for fiber optic connections, without repeaters, at communication data rates of up to 64 kbps. The trunk may be extended up to 20,000 feet through the use of wire repeaters or 80,000 feet through the use of fiber optic repeaters. At data rates of up to 19.2 kbps, the trunk distance shall be extendible to distances of up to 20,000 feet using RS-485 communication wire or fiber optic repeaters. A repeater shall be used each 4,000 feet of linear distance for wire or every 6,500 feet for fiber optics. Repeating devices shall contain separate LED indication for each communication interface trunk to indicate proper operation of the repeater as well as the communications trunks.
Contractors shall provide devices which are of FMCS control system manufacturer's design.
- d. It shall be possible for the trunk to be "T" eed or "starred", at any location using a repeater, to facilitate the installation. Systems which do not provide this capability shall provide a trunk riser diagram showing end to end distances and locations of system topology necessary to meet the trunk diagram shown on the plans.
- e. **Fiber Optic Communication Trunk**
The temperature control contractor shall provide a dual channel fiber optic data link, as required, to minimize the effects of transient surges caused by lightning or external EMI generating equipment. The data link shall be comprised of a single duplex cable containing two fibers (transmit and receive), of 62.5 micron construction, to accommodate data rates of up to 64 kbps.
The fiber optic trunk shall be connected to SDC devices using manufacturer's standard RS-485 to fiber optic data link modem. Repeating devices shall contain separate LED indication for each communication interface and the fiber modem, to indicate proper operation of all aspects of the device. Fiber modem devices shall be tested and conform with transient surge withstand tests for electrical devices, ANSI C62.41 IEEE-587 Categories A and B. Manufacturer's data sheet shall provide evidence of compliance with this requirement. Manufacturer's products which do not meet this minimum performance requirement shall not be acceptable. Systems which require a special gateway controller to accommodate the fiber optic trunks, shall provide such a controller per point where the fiber optic cable enters and leaves the building. Gateway controllers shall not

inhibit transfer of point data values between SDC controllers throughout the LAN. Such inhibitive systems shall not be acceptable.

In lieu of the above two options, the contractor may provide a fiber optic link to each SDC controller within the LAN. All controllers shall have access to the fiber optic link for LAN.

Fiber optic cable shall be fully tested and terminated by the temperature control contractor.

E. Standalone Digital Controllers (SDC)

1. General

Standalone Digital Controllers (SDC) shall be 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.

The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board SDC controller database shall be performed on-line using the built-in or HHOT interface. Systems which require the SDC to be removed from service while DDC control sequences are modified shall not be acceptable.

SDC controllers shall utilize true floating point arithmetic capabilities. To accommodate totalization of large totalized values, SDC's with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power.

2. Database and Memory Back-up

All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC, shall be protected from loss due to power failure for a minimum of six months. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period. Systems not in compliance shall provide for uninterrupted power to each SDC.

3. Service Ports

SDC controllers shall be equipped with a minimum of one operator service port for the connection of a HHOT. The service port shall be either a built-in RS-232 data terminal port or an RJ-11 type jack which connects to the manufacturer's standard HHOT.

Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers.

The service port shall allow utilization of the same HHOT from any location. The same HHOT shall be utilized for any SDC, MSDC, AHDC, and UDC, Systems which utilize more than one variety of HHOT shall not be acceptable.

4. Display and Readout Capability

The SDC controller shall provide manufacturer's standard display and readout capability.

5. Manual/Auto Control and Notification

The SDC controller shall provide commanded override capability from the HHOT or the built-in operator interface. Such overrides shall be annunciated to the CHS's. Such overrides shall be valid as long as power is applied to the controller.

Manual service overrides, such as Hand/Off/Auto switches, shall be provided as indicated on the drawings. Such overrides shall be located at the controlled device location and conform with OSHA Manual lockout regulations, as appropriate, for safety reasons. SDC indication of such manual override actions shall be provided as feedback status indication points shown on the drawings, in conjunction with the application programs within the SDC. Systems which provide built-in H/O/A switching devices with integral feedback shall provide external manual service overrides, as indicated, to comply with OSHA manual lockout regulations. H/O/A switches remotely located at the SDC controller are not acceptable.

6. Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all set points used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual SDC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the SDC. From a single SDC user interface, any other SDC shall be accessible and full adjustment capabilities shall be provided.

7. Sensing and Control Outputs Requirements

a. Sensing

i. All sensing inputs shall be provided via industry standard signals. Temperatures, humidities, differential pressure signals, and other signal inputs shall be one of the following types:

1. 0-20 mA
2. 4-20 mA
3. 0-5 VDC
4. 0-12 VDC

ii. 1000 ohm platinum (at $0.00391 \text{ } ^\circ\text{C}/^\circ\text{C}$)

iii. 1000 ohm Balco ($2.2 \text{ ohms}/^\circ\text{F}$)

iv. 10 k ohm Thermistor (at $25 \text{ } ^\circ\text{C}/77 \text{ } ^\circ\text{F}$)

Custom, definable input signals (accept sensor inputs from RTD devices, other than those of the manufacturer).

All signal inputs shall be compatible with the controllers used, and with the requirements for readout of variables in true scaled engineering units

as specified.

b. Control Outputs

i. On/Off Outputs

Control panel shall internally provide test points for the circuit driving the equipment contactor, for the purpose of troubleshooting the 120 VAC or 240 VAC circuit to the contactor. All such relays or digital output modules shall provide a pilot light or LED display of the same status. On/Off output modules shall be of the modular construction that can be easily and quickly replaced, on an individual basis, if the module were to be damaged.

ii. Modulating Outputs

Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with definable output spans, to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also comply with the following requirements.

All modulating outputs shall provide within the control panel, a meter gauge, or display indication via on board display or HHOT, the commanded position signal for the actuating device. This meter, gauge, or display must provide either a 0-100 percent position indication, or read out directly in the engineering unit of the signal being used. Drive open/Drive closed type controllers shall include sufficient components and control algorithms to comply with this requirement. In the case of Drive open/closed technology, position feedback shall be provided to insure positive indication that the control device is at the commanded position.

F. Mechanical System Digital Controllers (Msdc's)

1. General

a. Controls shall be microprocessor based, Mechanical System Direct Digital Controllers (MSDC's). MSDC's shall be provided for air handling units, central pump systems and other applications as required. MSDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the MSDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates sensor signals. All input/output signal conversion shall be performed through a minimum of a 12 Bit A to D converter. All input/output points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input/output points must be available as universally definable at the owner discretion. If input/output points are not fully universal in nature, unused points must be equal in quantity between Analog Input, Digital Input, Analog Output, Digital Output.

Contractor shall provide a minimum of one MSDC controller per mechanical system, as shown on the drawings.

The BAS contractor shall provide and field install all MSDC's specified under this section. Mechanical Equipment manufacturers desiring to provide MSDC type controls as factory mounted equipment, shall provide a separate bid for their product less all controls, BAS/Temperature Control Contractor.

b. All input/output signals shall be directly hardwired to the MSDC. Trouble

shooting of input/output signals shall be easily executed with a volt-ohm-milli-amp meter (VOMA). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be used.

- c. MSDC shall be in continuous direct communication with the network which forms the facility-wide Building Automation System (BAS). The MSDC's shall communicate with the SDC at a baud rate of not less than 19,200 baud.

2. Non-Volatile Memory

- a. All control sequences programmed into the MSDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the MSDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The MSDC shall allow for the creation of unique application control strategies. Systems that allow selection of sequences from the library or table are not acceptable.
- b. All control sequences shall be fully field programmable at the MSDC controller, allowing for the creation or editing of an application sequence of operations.
- c. Each MSDC shall be provided with manufacturer's standard built-in Operator Interface.
- d. The MSDC shall allow for internal processing and reporting of user defined Time of Day Schedules, Alarms, Trend Reports, Run Time Totalization, Energy Utilization Reports, Application Program Documentation and interface with a peripheral device such as an autodial/autoanswer modem, a VT-100 Display Terminal, or a serial printer.
 - i. Systems not providing the above functionality at the MSDC are not acceptable and shall utilize an SDC in place of the MSDC.
- e. The MSDC shall provide LED indication of transmit/receive communications performance as well as for the proper/improper operation of the controller itself.
- f. The MSDC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days without loss of setting. The battery for the time clock shall be field replaceable by the customer. Integral daily, weekly, holiday and special event scheduling shall be provided, such that all schedules can be custom tailored to the facility. Predefined schedules, with set quantities of on/off cycles are not acceptable.

3. Controller Location

- a. To simplify controls, mechanical service and troubleshooting, the MSDC shall be mounted directly in or on the control compartment of the mechanical system. The MSDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The MSDC shall be constructed in a modular orientation such that service of the failed components can be performed quickly and easily. The modular construction should limit the quantities of printed circuit boards to a

maximum of three. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. The MSDC shall allow for the creation of, unique, application control strategies. Systems that allow selection of sequences from a library or table are not acceptable. This shall allow all controls maintenance and troubleshooting to be made while at the unit location. MSDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

- b. For compatibility to the environment of the mechanical systems, MSDC shall have wide ambient ratings. MSDC shall be rated for service from -40 Deg F (Degrees Fahrenheit) to 140 Deg F.
- c. Contractor shall submit description of location for the MSDC's on all mechanical equipment.

G. Air Handler/Energy Recovery Unit/Make-up Air Unit/H&V Unit Digital Controller (AHDC)

1. General

- a. Controls shall be microprocessor based, Air Handler Digital Controllers (AHDC's). AHDC's shall be provided for air handling units, H & V units, energy recovery ventilators, make-up air units, and other applications as required. AHDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the AHDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.
Contractor shall provide a minimum of one AHDC controller per air handling system as shown on the drawings.
The BAS contractor shall provide and field install all AHDC's specified under this section. Mechanical equipment manufacturers desiring to provide AHDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.
- b. All input/output signals shall be directly hardwired to the AHDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
- c. AHDC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The AHDC's shall communicate with the SDC at a baud rate of not less than 19,200 baud.

2. Non-Volatile Memory

- a. All control sequences programmed into the AHDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the AHDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The AHDC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table, are not acceptable.
- b. All control sequences shall be fully programmable at the AHDC, allowing for the creation and editing of an application control sequence, while at the unit.
- c. The AHDC shall be provided with an interface port for the HHOT. The interface port shall allow the HHOT to have full functionality as described. From the interface port, the HHOT shall be able to directly access any AHDC or UDC in the network.
- d. The AHDC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days. Systems unable to provide the above capability shall provide for the individual Input/Output point trending at the SDC. Specifics as to how each AHDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of AHDC's per SDC that can be expected.
- e. The AHDC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.
- f. The AHDC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the AHDC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The AHDC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

3. Controller Location

- a. To simplify controls and mechanical service troubleshooting, the AHDC shall be mounted directly in or on the controls compartment of the air handling system. The AHDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The AHDC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and

input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The AHDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

- b. For compatibility to the environment of the air handling unit, AHDC's shall have wide ambient ratings. AHDC's shall be rated for service from -40 Deg F (Degrees Fahrenheit) to 140 Deg F.
- c. Contractor shall submit description of location of AHDC's on all mechanical and air handling equipment.

H. Unitary Digital Controller (UDC)

1. General

- a. Controls shall be microprocessor based Unitary Digital Controllers (UDC's). UDC's shall be provided for equipment as necessary. UDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the UDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.

Contractor shall provide a minimum of one UDC controller per unitary system as required.

The BAS contractor shall provide and install all UDC's specified under this section. Mechanical equipment manufacturers desiring to provide UDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

- b. All input/output signals shall be directly hardwired to the UDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm-milli-amp meter (VOMA). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
- c. UDC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The UDC's shall communicate with the SDC at a baud rate of not less than 9,600 baud.

2. Non-Volatile Memory

- a. All control sequences programmed into the UDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the UDC memory to be lost, nor shall there be any need for batteries to be recharge or replaced to maintain the integrity of the controller database. The UDC shall allow for the creation of unique application control sequences. Systems that allow only selection of sequences from a library or table are not acceptable.
- b. All control sequences shall be fully configurable at the AHDC, allowing

- for the creation and change of a sequence while at the unit.
- c. The UDC shall be provided with the ability to interface with the HHOT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the HHOT to have full functionality as described hereinbefore of this specification. From the interface port, the HHOT shall be able to directly access any AHDC, and UDC, in the network.
 - d. The UDC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. Systems unable to provide the above capability shall provide for the individual input/output point trending at the SDC. Specifics as to how each UDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of UDC's per SDC that can be expected.
 - e. The UDC shall provide LED indication of transmit/receive communication performance, as well as for the proper/improper operation of the controller itself.

3. Controller Location

- a. To simplify controls and mechanical service troubleshooting, the UDC shall be mounted directly in the controls compartment of the unitary system. The UDC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The UDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
- b. For compatibility to the environment of the unitary equipment, UDC's shall have wide ambient ratings. UDC's shall be rated for service from 32 Deg F (Degrees Fahrenheit) to 140 Deg F.
- c. Contractor shall submit description of location of UDC's on all mechanical and unitary equipment.

I. Gateway Digital Controller (GDC)

1. General

- a. Controls shall be microprocessor based, Gateway Digital Controllers (GDC's). GDC's shall be provided for the purpose of integrating microprocessor based, communicating, direct digital control systems from vendors other than the primary, selected controls manufacturer. GDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the GDC. All communications interface control programs shall be resident within the

GDC.

The BAS contractor shall provide and field install all GDC's specified under this section. Any interface requirement beyond a two wire communications wire link, shall be provided by the equipment manufacturer supplying the non-primary or third party microprocessor based, communicating, direct digital controllers.

- b. All GDC's shall exist at the LAN level with the SDC's. The GDC's shall possess all capabilities described under the SDC section while additionally providing the interface to the third party systems described above. The GDC's shall communicate with the third party controllers at the highest possible baud rate offered by the third party system. As a minimum, 9,600 baud communications shall be utilized.
- c. All control sequences programmed into the GDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The GDC shall allow the standard database information from the third party system to be integrated in standard FMCS data formats, allowing for the creation of unique application control sequences. Systems that only allow selection of data and sequences from a library or table, are not acceptable.
- d. Each GDC shall be provided with manufacturer's standard built-in operator interface.
The GDC shall provide Alarming, point trending and Energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. Such alarm shall be provided with a unique 80 character message. Systems utilizing an alarm message library, shall describe the size of the library and verify how all alarming within the GDC will be guaranteed unique 80 character messages.
The quantities of trended point values shall be limited only by total controller memory space. If necessary, a GDC may be dedicated fully to a trending task, allowing all controller memory to be available for the trend storage. Each unique trend report shall contain a minimum of 4 different points and a minimum of 128 samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample once every 24 hours. Trend reports shall be internally formatted by the GDC and shall be reportable directly to a serial printer, a VT-100 display terminal, a CCS, CHS or any other device capable of receiving a formatted ASCII data file.
- e. The energy reports shall not be limited in quantities only by available memory within the GDC. Each Energy Report shall be fully formatted and reportable to a serial printer, a VT-100 display terminal, a CCS, a CHS or any other device capable of receiving a formatted ASCII data file. As a minimum, each Energy Report shall provide a daily report and a monthly report with summary information such as outside air temperature, outside air humidity, total energy consumed and degree day calculations.
- f. The GDC shall be provided with a battery backed clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the GDC, without loss of setting. The battery for the time clock shall be field replaceable by the customer.

2.11. SYSTEM SOFTWARE DESCRIPTION

A. General

1. Contractor shall provide all software for a complete and operational system as described herein. Software shall include manufacturer's standard multi-tasking, multi-user operating system for operator consoles and controllers, network communication software for dial-up and hard trunk applications, operator man-machine interface software, control application software and all other software necessary to provide the functions specified herein.
2. System software shall be as manufactured by Siebe Environmental Controls, Johnson Controls, Honeywell, Siemens, Alerton, Reliable Controls, Schneider Electric, Advanced Power, Trane, or approved equal.

2.12. EXCEPTION REPORTING SEQUENCES

A. Alarm/COS Reports

1. For those digital points indicated on the drawings, the Contractor shall provide a unique change-of-state alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.
2. For those points indicated on the drawings which are designated as interrupt priority, the Contractor shall provide an interrupting process display at the CHS location which displays the current conditions for the operator.

In addition, the CHS computer shall automatically send a picture of the process graphic display to the remote locations specified on the drawings as receiving facsimile copies of interrupting alarms.

3. For those points designated in paragraph 3 above, the FMCS shall also send a history log to the system report printer of the immediate prior history of the points causing the interrupt priority. This log shall contain 1 minute samples of the previous 15 minutes of operation.
4. For those points on the drawings designed as Hard Facts points, the Contractor shall provide an alarm message to a remote facsimile location designated by the Owner. The FMCS system shall provide at the remote location, a facsimile print-out showing location, time/date of alarm and alarm message of the point. For interrupt priority fax alarms, the remote facsimile machine shall receive a hard copy of the interrupt process screen showing on-line dynamic data values of the current conditions.

B. Off Hours Exception Reporting

1. The Owner shall specify up to five sites to which off hours exceptions shall be auto-dialed and reported. This shall allow the owner to assign off hours exception responses to various facility personnel as necessary. Selection of the site to be dialed can be programmed by the Owner, and set to change automatically per time of day and day of week.

2.13. MONITORING SYSTEM, SENSORS AND WIRING

A. Sensors and other Devices for Input/Output Summary Schedule:

1. Provide all necessary sensors, relays, panels, conduits and wire for the points indicated in the input/output summary as shown on the contract drawings.
2. Analog sensing elements for remote indication shall be independent of local sensors used for local control loops.
3. Temperature sensors shall be Resistance Temperature Detector (RTD) type of 1000 ohm balco. Space (60-90 degrees F); Duct/Well (-30-250 degrees F); Averaging Duct (-30-225 degrees F) or as required under Division 26.
 - a. Space temperature sensors shall be provided with blank commercial type locking satin chrome covers.
 - b. Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation. Water sensors shall be provided with a separable copper, monel or stainless steel well. Outside air wall mounted sensors shall be provided with a sun shield.
 - c. The dew point sensor shall employ a non-reactive organic bobbin material to give precise dew point readings with accuracy of not more than + 1.5 degrees F. The dew point sensor shall incorporate an integral draft shield as part of the instrument for air velocities in excess of 50 feet per minute. The dew point sensor shall operate over a minimum dew point temperature range suitable to application.
4. Relative humidity sensors shall be capacitance type with 10 percent to 90 percent range. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with covers identical to temperature sensors. Space 10 percent -90 percent RH; Duct 10 percent - 90 percent RH.
5. All wall mounted temperature sensors, humidity sensors, and CO2 sensors shall be installed with stainless steel wire guard. Set point adjustment shall be achievable without removing the wire guard.
6. Differential and Static Pressure Sensors and Switches
 - Fan proof-of-flow switches shall be U.L. listed adjustable set point and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch WG, they shall be piped across the fan. For fractional horsepower and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inches WG. with .05-12 inch W.C. range.
 - a. Pump proof-of-flow switches shall be U.L. listed adjustable differential pressure or flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches shall have valved manifold for servicing, and a range of 3 psi-150 psi.
 - b. Air flow and static pressure analog sensors shall be high accuracy suitable

- for the low velocity pressures to be encountered, be selected for approximately 50 percent overrange, and have a 4 to 20 ma output. These differential pressure sensors shall be connected to the air flow measuring station with valved lines for testing and calibration, and shall have adjustments for zero and span. 5 inch W.C. range.
- c. Water flow analog sensors shall be provided complete with flow element and shall be an all solid state precision industrial type with stainless steel meter body, maximum error of no more than .5 percent or span, and 4 to 20 ma output. Sensor shall be rated for 250 psi minimum and installed in strict accordance to the manufacturer's instructions complete with three-valve manifold for calibration and maintenance.
7. Overall system accuracy, including electronic analog sensing elements, shall be as follows:
 - a. Air: Plus or minus 1.0 degrees F temperature, plus or minus 2.5 percent r.h., plus or minus 2.0 percent static pressure.
 - b. Water: Plus or minus 0.7 degrees F over full scale range for water points, plus or minus 1.0 degree F for others.
 - c. Proof of fan or pumps operating status, or alarm conditions shall be through positive feedback from differential pressure switches across fan or pump. Auxiliary dry contacts may be used for proof of fans or pumps if the motors are fractional H.P., and other non-ducted fans.
 8. Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration shall be provided. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirements.
 9. Liquid flow data shall be received and transmitted by commercial grade instrument similar in quality to Honeywell 411, Rosemount, Foxboro, MAMAC Systems or approved equal, type differential pressure transmitter. Pulse type data sensors shall not be acceptable. Speed response of differential pressure transmitters shall be at least 500 milliseconds. Maximum error signal shall be +/- 1 foot.
 10. Start-stop relay module shall contain relays for start-stop function at the remote point, with relays mounted and factory wired to numbered terminal strips.
 11. Outage Devices:
 - a. Control Relays: Control relay contacts shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life-span rating of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression limiting transients to nondamaging levels.
 - b. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Relays shall be

equipped with coil transient suppression devices to limit transients to nondamaging levels. Delays contact opening or closing shall be adjustable from one to 60 seconds with a minimum accuracy of plus or minus 2 percent of setting.

- c. Latching Relays: Latching relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life-span rating of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to nondamaging levels.
- d. Reed Relays: Reed relays shall be encapsulated in a glass-type container housed in a plastic or epoxy case. Contacts shall be rated for the application. Operating and release times shall be one millisecond or less. Reed relays shall have a minimum life span rating of 10 million operations.
- e. Contactors: Contactors shall be of the single-coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be double-break silver-to-silver type protected by arcing contacts. Number of contacts and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to nondamaging levels.
- f. Solid-State Relays: Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 V rms or greater at 60 Hz. The contact life shall be 10 million operations or greater. The ambient temperature range shall be minus 20 degrees to plus 140 degrees F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release times shall be one millisecond or less. Transient suppression shall be provided as an integral part of the relay to limit transients to nondamaging levels.

12. Audible Alarm:

- a. All alarms shall annunciate on the ATC system front end computer and via pagers.

2.14. CARBON MONOXIDE SENSORS

- A. Carbon Monoxide (CO) sensors shall be Tox-CO/ANA as manufactured by Tox Alert, Inc., or approved equal. CO sensors shall be low voltage devices (24 VAC supply) with 4 to 20 mA output to be utilized with direct digital controller. Unit shall have 4 to 20 mA signal, which is linear over the sensor 0 to 400 ppm CO range. Locate CO sensors as indicated on Contract Drawings with vandal-proof locking cover.
- B. Provide sensors with control system with audible alarm 0-10V DC output for exhaust fan interlock, and output for existing door operator interlock. Provide system in manufacturer standard cabinet with locking door for surface mounting.

2.15. MAKE-UP WATER FLOW METER/ALARM

- A. In-line T-mounted Flowmeter: Made for installation between pipe flanges; measures flow directly in gallons per minute. As manufactured by Aaliant, Badger, Hersey, Kele, Data Industrial or approved equal.
 - 1. Construction: Stainless steel body, with integral transmitter and direct - reading scale.
 - 2. Pressure rating: 400 psig maximum.
 - 3. Temperature Rating: 221 F maximum
 - 4. Display: Two lines; alphanumeric characteristic each. Visual instantaneous rate of flow, with register to indicate total volume in gallons.
 - 5. Output: Two simultaneous outputs; 4 to 20 mA, two-wire, pulse.
 - 6. Transmitter: Universal flow transmitter with pulse output (totalization) to convert digital pulses to totalized gallons.
 - 7. Electronic Housing: NEMA4, 3/4 NPT conduit connection, epoxy coated aluminum.
 - 8. Accuracy: Plus or minus 1 percent of reading.
 - 9. Key Pad: Setting of recalibration, engineering units, data logging sample time, alarms, response time.
- B. Power and control wiring to be furnished and installed under this Section of Division 23.

2.16. FLOW MEASURING STATIONS

- A. Furnish and install an Onicon Model F-1210, Hersey, Kobold or approved equal dual turbine insertion flow sensor complete with hot tap full port ball valve and installation hardware. The dual turbine element shall have counter rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Paddle type rotors will not be acceptable. Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photo-electric means. Each sensor shall be individually calibrated and tagged accordingly against the manufacturers primary standards which must be accurate to within 0.1 percent and traceable to the U.S. National Institute of Standards and Technology (NIST).
- B. The sensor shall have a maximum operating pressure of 400 PSI, maximum operating temperature of 220 degrees F (optional 300 degrees F) and a pressure drop of less than 1 PSI at 17 feet per second flow rate. Flow sensor shall have 100:1 turndown ratio. Accuracy shall be + 2 percent of actual reading from 0.4 feet per second to 20.0 feet per second.
- C. The sensor shall have integral analog outputs of 0-10 VDC and 4-20 mA current output for connection to the Central Control System. The sensor shall also include three integral frequency outputs, (top turbine, bottom turbine, average frequency) for diagnostic purposes and for connection to peripheral equipment (local display, BTU meter, etc.). All outputs

shall be linear with flow rate.

- D. The turbine elements shall be made of polypropylene with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be constructed of 316 stainless steel with an aluminum electronics enclosure and gasketed cover.
- E. Install flow measuring stations with minimum straight lengths of pipe upstream and downstream from sensor as prescribed by manufacturer's written instructions.
- F. Make electrical connections to power supply and interlock with ATC system.
- G. Calibrate meters for manufacturer's requirements.

2.17. FIELD INSTALLED CONDENSATE OVERFLOW SWITCHES

- A. Condensate overflow switches must be tested to comply with U.L. 508.
- B. Interlock condensate overflow switches to shut-down cooling equipment and alarm on ATC system where overflow condition exists.

2.18. CO2 SENSORS/TRANSMITTER

- A. Furnish and install wall mount CO2 sensor/transmitters at locations indicated on floor plans. CO2 sensor/transmitter shall be model CD-W00 as manufactured by Johnson Controls or approved equal.
- B. Measuring Range: 0 to 2,000 ppm CO2.
- C. Response Time: 1 minute
- D. Output Signal: As required by ATC system
- E. Max power consumption: Less than 2 watts.
- F. Listing: U.L. Listed
- G. Accessories: Mounting Kit, Transformer required.
- H. Where installed in toilet rooms, locker rooms, shop/repair areas and corridors install heavy duty stainless steel guards.

PART 3. EXECUTION

3.1. GENERAL

- A. The Automatic Temperature Control System and Central Control and Management System, shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner.

3.2. BMS SPECIFIC REQUIREMENTS

- A. Graphic Displays

1. Provide a color graphic system flow diagram display for each new system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:

1. Provide custom reports as required for this project:

3.3. WORKSTATION INSTALLATION

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power each workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's and Architect's review and feedback.
7. Refine graphics as necessary for Owner acceptance.

8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.4. INSTALLATION & SUPERVISION

- A. All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.
- B. The control contractor shall be responsible for all electrical installation required for a fully functional control and automation system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance to all local and national codes.
 1. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications.
 2. All electric and electronic wiring shall be minimum #20 AWG minimum THHN and shielded if required.
 3. All wiring in the central control room shall be concealed in an approved manner.
- C. Verify locations of temperature sensors, humidity sensors, CO2 sensors, and other exposed control sensors with plans and Owner prior to installation.
- D. The installation and supervision of this project shall be carried out by factory trained personnel who are employed by the Contractor and licensed for this type of work.
- E. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- F. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- G. Install in accordance with manufacturer's instructions.
- H. Check and verify location of space temperature sensors, humidity sensors, CO2 sensors, and other exposed control sensors with plans and room details before installation. Align with lighting switches and humidistats.
- I. Mount freeze protection thermostats using flanges and element holders.
- J. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- K. Provide separable sockets for liquids and flanges for air bulb elements.
- L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls

inside cabinet and engraved plastic nameplates on cabinet face.

- M. Install equipment plumb and level.
- N. Install all equipment to be accessible for service and maintenance.

3.5. ACCEPTANCE TESTING

A. Point Verification

To verify end-to-end operation of the system the Contractor shall provide a hard copy of an All Points Summary Listing to the Owner of each part or system to be placed in warranty by the Owner. For CHS systems, the Contractor shall additionally provide a print screen of the process display showing real time dynamic point information for all points on the subsystem(s) to be accepted.

B. Sequence Verification

- 1. The Contractor shall notify the Owner's representative of systems which perform all specified sequences.
- 2. The warranty acceptance test shall be of 5 days duration and the system shall perform as follows:
 - a. During the five days, the FMCS system shall not report any system diagnostics from the subsystem under test.
 - b. The subsystem shall be performance verified as operational using temporary trends of each control loop located in the SDC or MSDC.
 - c. During the occupied periods, BAS control loops, under test, shall maintain control of the process variable within the following scales:
 - i. Duct Static Pressure +/-0.3 inch WC
 - ii. Pump Head Pressure +/-10 percent of control range
 - iii. Duct Temperature Loops +/-2 degrees F
 - iv. Room Temperature Loops +/-1degrees F
 - v. Pipe Temperature Loops +/-2 degrees F
 - vi. Duct Humidity +/-2x rated error of Humidity Transmitter
 - d. The contractor shall provide a hard copy printout of the process variable, process variable set point and control loop output percent for the period of 2 hours prior to occupancy to 2 hours after occupancy with samples taken every 15 minutes.

3.6. COORDINATE WITH TAB AGENCY

- A. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, freeze stats and duct smoke detectors.
- B. Verify that all controlling instruments are calibrated and set for design operating conditions prior to commencement of TAB work.
- C. Calibrate sensors after installation, and before the sensor control verification tests are

performed. Prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditional space for each separately controlled zone.

- D. Allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.
- E. All control sequences, software, equipment, and components shall be started-up by a qualified technician. Start-up report shall be submitted to Engineer prior to the commencement of testing and balancing work. Testing and balancing shall not commence until start-up reports are completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

3.7. EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and tubing is installed prior to installation proceeding.

3.8. INTERLOCK REQUIREMENTS

- A. The fan and equipment interlock requirements are as scheduled on the contract drawings.
- B. Furnish and install all necessary relays, transformer, contactors, wiring, conduit, and accessories to perform fan, equipment, and damper interlocks.
- C. Unless otherwise noted, fan interlocks shall be arranged such that dampers associated with fan shall be open when fan starts and close when fan stops.

3.9. SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

3.10. CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.
- B. Ground equipment.
 1. 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.
- C. Connect hand-off-auto selection switches to override automatic interlock controls when switch is in hand position.

3.11. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
 8. Test all end switches and verify status is reported on the ATC system.
- C. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- E. All temperature control and interlock wiring shall be installed in conduit unless otherwise noted on the plans. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

3.12. ADJUSTING

- A. Calibrating and Adjusting:
 1. Calibrate instruments.
 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using volt-ohm-milli-amp meter (VOMA) at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 0, p50, 90, and 100 percent of span.

- b. Manually operate flow switches to verify that they make or break contact.
 - 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 - 8. Stroke and adjust control valves and dampers.
 - 9. Provide diagnostic and test instruments for calibration and adjustment of system.
 - 10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
 - B. Adjust initial temperature and humidity set points.
 - C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.
- 3.13. ON-SITE ASSISTANCE
- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.
- 3.14. SCHEDULING
- A. Submit spreadsheet to Owner indicating occupied/unoccupied times for each item controlled by ATC system. Incorporate all scheduling requirements into sequence of operation.
- 3.15. STAGING
- A. Coordinate staging requirements with equipment being controlled. Where multistage units are scheduled or specified, provide all devices, controllers, wiring to control and sequence all stages.
- 3.16. VRF/VRV SYSTEMS INTEGRATION

- A. For VRF/VRV systems the building automation system contractor shall:
1. Supply all the application software to read and write all points available from the VRF/VRV systems BACnet gateway.
 2. Supply all physical points for the VRF /VRV equipment not supplied by the VRFVRV systems BACnet gateway to meet the sequence of operation and control strategy of the Building Automation Systems.
 3. Not exceed the maximum read writes to points for the yearly buffer and storage of data limits for the VRF/VRV equipment.
 4. Request the timing requirements for the loading of communications between Building Automation Systems and VRF/VRV Systems BACnet gateway limitation.
 5. Additionally, the Building Automation System shall be capable of providing daily, weekly, yearly, and holiday programmable scheduling of Occupied/Unoccupied settings, On/Off, Mode of Operation, set point and fan speed based on the available functions of the connected VRF/VRV systems.

PART 4. SEQUENCES OF OPERATION

- 4.1. REFER TO CONTRACT DRAWINGS FOR SEQUENCES OF OPERATION, CONTROL DIAGRAMS, AND POINTS LIST.

END OF SECTION

SECTION 233000 - HVAC AIR DISTRIBUTION

PART 1. GENERAL

1.1. SUMMARY

- A. For General Mechanical Requirements, see Division 23 Section, "Common Work Results for HVAC" and Division 01, "General Requirements".
- B. The fabrication and installation of all ductwork, together with related equipment, shall comply with the standards of the National Fire Protection Association, as set forth in NFPA Standard No. 90A, as well as with the requirements of the Sheet Metal and Air Conditioning Contractors' National Association, Inc., and the latest edition of the ASHRAE Guide.
- C. All duct sizes shown are net inside clear dimensions. Where internal duct lining is used, increase duct sizes accordingly to provide the indicated net free area. Unless otherwise indicated size runouts, drops, and connections to grilles, registers, diffusers, fans, coils, louvers, filters, and other equipment to the full size of the equipment connection.
- D. Minor changes may be made in duct sizes where required to fit the available space, provided the indicated net free area and approximate aspect ratio are maintained.
- E. Smoothly transition all ductwork to prevent excessive or unnecessary turbulence or pressure loss.
- F. All exposed ductwork in finished areas shall be painted in color as indicated by Architect. All ductwork requiring paint shall be constructed of paint grade galvanized sheet steel with a paintable finish.

1.2. REFERENCES

- A. ASTM A 36 - Structural Steel
- B. ASTM A 90 - Weight of coating on Zinc-Coated (Galvanized) Iron or Steel Articles
- C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- D. ASTM C 916 Type II – Standard Specification for Adhesives for Duct Thermal Insulation
- E. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quality
- F. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
- G. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
- H. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality
- I. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled

- J. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality
- K. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate
- L. AWS D9.1 - Welding of Sheet Metal
- M. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
- N. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems
- O. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
- P. SMACNA - HVAC Air Duct Leakage Test Manual
- Q. UL 181 - Factory-Made Air Ducts and Connectors.
- R. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
- S. NFPA 70 - National Electrical Code
- T. SMACNA - HVAC Duct Construction Standards - Metal and Flexible
- U. UL 33 - Heat Responsive Links for Fire-Protection Service.
- V. UL 555 - Fire Dampers and Ceiling Dampers

1.3. PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE Table of Equivalent Rectangular and Round Ducts.

1.4. QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the projects specified in this section with minimum five (5) years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum five (5) years' experience.

1.5. REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA- 90A, and NFPA-90B.

1.6. ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturer.
- B. Maintain temperatures during and after installation of duct sealants.

1.7. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. DUCTWORK

- A. Unless otherwise indicated or specified, fabricate ductwork of galvanized sheet steel, stainless steel, or aluminum conforming to Commercial Designation 3003 Temper H14 and Duct Sheet. Duct gages, jointing and reinforcement shall conform to Tables 4, 5, 6 and 7, as applicable, Chapter I of the latest ASHRAE Guide and Data Book. Construction details shall conform to Section I and Section II, as applicable, of Duct Manual and Sheet Metal Construction for Ventilation and Air Conditioning Systems as published by Sheet Metal and Air Conditioning Contractors' Association, Inc.
- B. Erect sheet metal ductwork in a first-class, workmanlike manner secured in place rigidly and permanently. Provide suitable hangers, securely attached to building construction with bolts, clips or inserts. Hangers shall be structural shapes, flat bars, or formed strap hangers; use of wire will not be permitted. Hangers shall not pass through or be inside duct. Support vertical ducts passing through floors by angles riveted to duct and resting either on floor or on brackets secured to building construction. All space around ducts where they pass through any walls, floors, ceilings, or roofs shall be sealed tight with incombustible inert material. Do not arrange ducts so as to impair the effectiveness of fireproofing around structural members. Provide sheet metal flanged collars around exposed ducts passing through walls, floors, or ceilings to provide finished appearance. Seal all duct joints and seams including supply, return, outside air, combustion air, relief air, ventilation air and exhaust ductwork with Hardcast Sealing System as manufactured by Hardcast, Inc., Foster, Childers, or approved equal.
- C. Flexible connections of neoprene or other NFPA approved non-inflammable fabric shall be provided in the duct system at all fan inlet and outlet connections.
- D. Provide cut turning vanes in all duct turns where centerline radius is located. Turning vanes shall be air-foil type with extended trailing edges. Fabricate to comply with SMACNA Sheet Metal Construction for Ventilation and Air Conditioning Systems Manual.
- E. Provide duct collars and angle iron framework for mounting of automatic dampers.
- F. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- G. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- I. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4-inch (100 mm)

cemented slip joint, brazed or electric welded. Prime coat welded joints.

- J. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- K. Fasteners: Rivets, bolts, or sheet metal screws.
- L. Hanger Rods: ASTM A36 - Galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.2. DUCT SYSTEMS

- A. All supply, return, exhaust, fresh air intake, relief, ventilation, outside air and combustion air ductwork shall be constructed for low pressure service (2 inch W.G.). All exposed round ductwork in finished areas shall be paintable grade, dual wall, constructed for medium pressure service (6 inch W.G.).
- B. Refer to Division 23 Section, Carbon Monoxide Exhaust System for ductwork associated with Carbon Monoxide Removal Systems.

2.3. DUCT CONSTRUCTION

- A. Rectangular and/or Round Ductwork (Low Pressure):
 - 1. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G-90 Zinc coating in conformance with ASTM A90.
 - 2. Make allowance for internal duct lining where required. Sizes shown on the drawings are inside clear dimensions.
 - 3. Determine duct gauges for the longest duct side and use for all four sides. Joints and reinforcing requirements apply to the longest duct side.
 - 4. Reinforce all ducts to prevent buckling, vibration, or noise as recommended in the referenced construction standards, and as required to suit the installed conditions.
 - 5. Do not cross break duct which will receive rigid insulation covering.
 - 6. Where tap sizes of divided-flow fittings are not indicated, make branch and main/connection sizes proportional to their respective air flows and maintain uniform transverse velocities in the fitting.
 - 7. Make radius elbows and radius tee connection with throat radius equal to or greater than the width of the duct. Use vaned elbows where shown and where radius elbows will not fit the space, and in all square bends.
 - 8. Turning vanes shall be the air-foil type with extended trailing edges, 36-inch maximum vane length. Where longer vanes are required, use two or more sets of vanes with intermediate runners securely fastened together.
 - 9. Bolt, screw, rivet, or spot weld reinforcing members securely to the duct on not less than 6-inch centers.
 - 10. Where ducts are open-ended without grilles, registers, or other means of

stiffening, reinforce and stiffen the open end with standing seams or an angle frame. Provide rolled edges to prevent any exposed sharp edges.

11. Paint all cut ends on galvanized angles, rods, and other uncoated surfaces with aluminum paint.
12. Where ductwork is not painted or otherwise finished, remove all exposed traces of joint sealers, manufacturer's identification and other markings.
13. Aluminum sheet shall be 3003 H14 alloy or duct sheet, 16,000 psi minimum tensile strength, and capable of being formed to a Pittsburgh lock seam.
14. Reinforcing members for aluminum ductwork shall be galvanized steel or aluminum unless otherwise indicated. Where aluminum reinforcing is used, size the member in accordance with ASHRAE recommendations to have rigidity equivalent to listed mild steel angle sizes.
15. Where aluminum ductwork is used, make allowance for increased thermal expansion. Particularly avoid direct contact between aluminum and concrete or masonry walls subject to dampness.
16. Determine duct gauges per SMACNA based on duct size and pressure indicated.
17. All Ductmate type ductwork shall be constructed for medium pressure service (6 inch W.C.)

B. Round and/or Rectangular Ductwork (Stainless Steel Type 316):

1. Stainless steel ducts: ASTM A167, Type 316.
2. All stainless steel ducts shall be round longitudinal seam or rectangular stainless steel Type 316. Determine duct gauges suitable for duct diameter and welded joints.
3. All longitudinal seams shall be installed with seam up.
4. These exhaust systems are low pressure service.
5. All elbows are round. Ninety degree squared elbows are not permitted.
6. All joints are welded by gas fusion using rods of similar materials.
7. All dampers, manual and motorized, shall be stainless steel Type 304.
8. These exhaust systems shall be fabricated and installed in strict accordance with requirements of SMACNA and NFPA.
9. Provide stainless steel guy wires, stabilizers, tensioners and accessories at upblast fan discharge ducts.
10. All exterior exhaust ductwork shall be Type 316 stainless steel. Exterior rectangular exhaust ductwork shall be beveled and crossbroken for proper drainage.

C. Round Ductwork (Dual Wall - Medium Pressure)

1. Medium pressure flat oval and round ductwork shall be spiral lock-seam Type K-27 with Type P liner as manufactured by United Sheet Metal Company, Inc., Semco Manufacturing, Inc., Lindab, Ductmate, MKT Metal Manufacturing, or approved equal, Uniseal duct and Uniform fittings. Construct ductwork of galvanized sheet steel. Elbows 8 inches in diameter and smaller shall be smooth formed. Larger elbows shall be five section type. Tees and crosses and laterals shall be conical. Make joints with sleeve type couplings, short length sheet metal

screws and duct sealant. Seal joints with Hardcast, Foster, Childers, or approved equal, as hereinbefore specified. Conform to duct manufacturer's recommendations for jointing and installation. Ductwork and fittings shall be manufactured by a company regularly engaged in the construction of spiral ductwork and fittings. Contractor-fabricated ductwork will not be acceptable for ductwork and fittings. Manufacturers substituted for the above specified manufacturers shall submit for approval independently published laboratory test data on all proposed ductwork and fittings showing materials of construction, air flow, pressure drop and acoustical performance characteristics.

2. Round dual wall ductwork shall be installed to the extent shown on the drawings. All duct lining shall be provided with a perforated galvanized liner on the surface exposed to the air stream. All exposed ductwork in finished areas and where indicated on contract drawings shall be painted in color as selected by Architect. All ductwork requiring paint shall be constructed of paint grade sheet steel with paintable finish.
3. Round dual wall ductwork shall contain a 2-inch thick fiberglass insulation sandwiched between inner and outer ducts.

D. Round/Flat Oval and/or Rectangular Ductwork (Single Wall Medium Pressure):

1. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized medium pressure sheet steel, lock forming quality, having G90 Zinc coating in conformance with ASTM A90.
2. Determine duct gauges based on duct diameter or duct size and pressures indicated.
3. Round and flat oval duct shall be spiral seam type.
4. All branch ducts shall connect to the main duct with a 45 degree conical lateral, or low loss fittings as shown on the drawings where possible. Where not possible, a 90 degree conical connection shall be used.
5. All elbows shall be long radius.
6. All seams and joints of fittings shall be welded by gas fusion with rod material same as duct material.
7. Connections to equipment shall be flexible material, NEMA approved, having adequate reinforcing to be compatible with internal pressure of system.
8. Paint all cut ends and welded joints with aluminum paint.
9. Make allowance for internal duct lining where required. Sizes shown on the drawings are inside clear dimensions. Rectangular lined ductwork shall have perforated metal liner, similar to that hereinafter specified.
10. Determine duct gauges for the longest duct side and use for all four sides. Joints and reinforcing requirements apply to the longest duct side.
11. Reinforce all ducts to prevent buckling, vibration, or noise as recommended in the referenced construction standards and as required to suit the installed conditions.
12. Do not cross-break duct which will receive rigid insulation covering.

13. Where tap sizes of divided-flow fittings are not indicated, make branch and main connection sizes proportional to their respective air flows and maintain uniform transverse velocities in the fitting.
14. Make radius elbows and radius tee connection with throat radius equal to or greater than the width of the duct. Use vaned elbows where shown and where radius elbows will not fit the space, and in all square bends.
15. Turning vanes shall be the airfoil type with extended trailing edges, 36-inch maximum vane length. Where longer vanes are required, use two or more sets of vanes with intermediate runners securely fastened together.
16. Bolt, screw, rivet, or spotweld reinforcing members securely to the duct on not less than 6-inch centers
17. Where ducts are open-ended without grilles, registers, or other means of stiffening, reinforce and stiffen, and open end with standing seams or an angle frame.
18. Remove all exposed traces of joint sealers, manufacturer's identification and other markings.

2.4. WASHROOM EXHAUST DUCTWORK

- A. Aluminum Ducts: ASTM B209, aluminum sheet, alloy 3003-H14. Aluminum connectors and bar stock: Alloy 6061-T6, or of equivalent strength stainless steel ducts: ASTM A167, Type 316.
- B. Ductwork shall be 20 gauge aluminum construction where concealed and 18 gauge Type 316 stainless steel where exposed.
- C. Ducts shall be constructed for low pressure operation with all seams liquid tight.
- D. Ductwork shall be pitched ¼ inch per foot back to hood or equipment for drainage.
- E. Provide a cleanout door of the same material as the ductwork for inspection and cleaning of interior duct surface. Cleanout shall be located in the vertical riser.

2.5. WATER HEATER/CONDENSING BOILER INTAKE DUCTWORK AND WATER HEATER EXHAUST DUCTWORK (PIPING) MATERIAL

- A. Refer to "Stacks and Breeching" for condensing boiler flue ductwork.
- B. Water Heater Exhaust Piping CPVC Pressure Pipe: ASTM F 441/F441M, solid-wall pipe.
 1. CPVC Socket Fittings: ASTM F 441/F441M pipe, socket type, and ASTM F438 socket type fitting.
 2. Joints: Solvent weld with solvent cement.
 3. Furnish and install roof curbs and roof terminations.
 4. Use CPVC solvent cement that has a VOC content of 490 g/l or less when calculated to 40 CFR 59, subpart D (EPA method 24).

5. Use CPVC primer that has a VOC content of 550 g/l or less when calculated to 40 CFR 59, subpart D (EPA method 24).
 6. Install lime chip neutralizer kit at all flue (exhaust) drain lines prior to discharge into floor drain. Condensate neutralizer shall be as manufactured by JJM Boiler Works or approved equal.
- C. Water Heater/Condensing Boiler Intake Piping – PVC Pressure Pipe: ASTM D2665, solid wall drain, waste and vent (schedule 40).
1. PVC Socket Fittings: Schedule 40 PVC, ASTM F89 socket fittings.
 2. Joints: Solvent weld with solvent cement.
 3. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6. AIR TRANSFER OPENINGS

- A. Furnish and install metal sleeves or frames, of the same material as the duct or air terminals attached thereto, in all air transfer openings through walls, partitions, floors and other building construction, extending completely through the opening. Securely fasten the sleeves or frames in place and provide face flanges on both sides. Where grilles or registers are required, attach them to the sleeve or frame, or extend ductwork where shown on the drawings. If no grilles, registers or duct connections are required, furnish and install ½ inch x ½ inch removable galvanized wire mesh on one face.

2.7. AIR VOLUME CONTROLS

- A. Furnish and install air volume control devices where indicated and where required to adjust and balance air flow in the systems, whether indicated or not. Volume dampers shall be provided in all branch ducts serving air outlets and inlets. For existing air devices install a new volume damper and where required for access, a new access door to allow access and adjustment.
- B. Air extraction for air outlets and branch ducts shall be the gang-operated vane type, Tuttle & Bailey - Vectrol, Type VLC or VLK as appropriate, or approved equal, with suitable adjusting device and means of access.
- C. Manual volume dampers in ductwork shall be factory-assembled units with rigid frame, opposed-blade action, and locking quadrant operator. Mark the extended damper shaft and align the operating handle to indicate the blade position. Dampers shall be as manufactured by Ruskin, American Warming and Ventilating, Inc., Arrow, or approved equal. Rectangular dampers shall be Type MD35, with steel channel frame, 16 gauge steel blades, 9 inch maximum blade spacing, low pressure, nylon bearings, galvanized finish with aluminum paint touch up. Round manual balancing dampers shall be Type MDRS25 manufactured by Ruskin, Arrow, American Warming and Ventilating, Inc., or as approved equal. When external insulation is to be applied, provide sheet metal standoffs on all manual volume dampers.
- D. Motor-operated dampers shall be as hereinafter specified under Division 23 Section,

“Instrumentation and Controls of HVAC & Plumbing System”.

- E. Duct turning vanes shall be Tuttle & Bailey Ducturns, or approved equal.
- F. Furnish and install duct collars and angle iron frames for the installation of ATC dampers.
- G. Provide Type 316 stainless steel motor-operated dampers for installation in stainless steel ductwork.
- H. Where volume dampers are installed in exposed finished spaces locate damper handle on top of duct.
- I. Where volume dampers are installed above ceilings attach a colored piece of tape so that Test and Balance Engineer can easily locate for air flow adjustment.

2.8. INSTRUMENT TEST PORTS

- A. Furnish and install instrument test ports in the ductwork to allow use of pitot tube length. Equip holes with Ventlok #699 instrument ports. Fittings shall extend beyond duct covering and insulation.

2.9. DUCT THERMOMETERS

- A. Duct thermometers shall be Dresser Industries, Trerice, Weiss, Weksler, Miljoco, or approved equal direct-mounting filled system dial thermometers. Duct thermometers shall be vapor-actuated, universal-angle dial type, cast aluminum case with 4 ½ inch diameter, glass lens. Duct thermometers shall include adjustable joint with finish to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal place, with locking device. Thermal bulbs shall be copper with phosphor-bronze bourden pressure tube. Movement shall be brass, precision geared. Duct thermometer scales shall be Progressive, satin-faced non-reflective aluminum with permanently etched markings. Each stem shall be copper-plated aluminum or brass for separable socket of length to suit installation.
- B. Where ductwork is installed at a height that would require duct thermometers to be installed 10 feet above finished floor or greater then remote-ready filled - system dial thermometers shall be installed. Connecting tubing shall be bronze, double-braided, armor-over-copper capillary; of length to suite installation.
- C. Duct thermometers shall be furnished and installed at air handling units, energy recovery ventilators, H & V units and make-up air units as follows:

LOCATION	RANGE
Outdoor Air Duct	-40 degrees Fahrenheit to 120 degrees Fahrenheit
Return Air Duct	40 degrees Fahrenheit to 180 degrees Fahrenheit

Mixed Air Plenum	30 degrees Fahrenheit to 180 degrees Fahrenheit
Supply Air Duct	30 degrees Fahrenheit to 180 degrees Fahrenheit
Exhaust Air Duct	30 degrees Fahrenheit to 180 degrees Fahrenheit

- D. Description: Flanged fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.
1. Extension Neck Length: Nominal thickness of 2 inches, but not less than thickness of exterior insulation.
 2. Insertion Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation lining.

2.10. FIRE DAMPERS

- A. Furnish and install automatic fire dampers where indicated, in all 2-hour fire-rated partitions, shafts, slabs, etc., and where required by NFPA Standard No. 90A and by the Fire Marshal. Refer to the architectural drawings for location of all fire-rated walls, shafts and slabs. Fire Dampers shall also be provided at all transfer air devices installed in rated walls at all floor penetrations, and as shown on the contract drawings.
- B. Construction of fire dampers shall conform to requirements of NFPA No. 90A, UL Standard 555 and shall bear UL label. Fire dampers shall be set in frames adequately secured to fire partitions, floors, etc., and installed in strict accordance with UL listing and manufacturer's instructions.
- C. Fire damper shall be Dynamic Type for rectangular ductwork and round ductwork as manufactured by Ruskin, Air Balance, Inc., Arrow, Greenheck, Lloyd Industries, Nailor, or approved equal, multi-leaf accordion type, held open by adequate heavy gauge wires and suitably calibrated fusible links. Vertical dampers (horizontal air flow) shall close by gravity. Horizontal dampers (vertical air flow) shall be closed by suitable and positive spring closing devices.
- D. Damper frames shall provide pocket which shall store the damper leaves in open position outside of the air stream and shall provide for 100 percent opening connecting to ductwork or grille face. Damper material shall match connecting ductwork.
- E. Provide adequately sized hinged access doors with cam locks for access to all fusible links and for resetting fire dampers. Where applicable, access to fire dampers shall be through registers or grilles. Provide identification on access door indicating fire damper within. Letters shall be not less than ½-inch in height.
- F. Submit complete information to the Engineer including installation details. Furnish and install sleeves, angles, break-away duct connections, per UL listing.
- G. Furnish to the Owner in a suitable storage container not less than six (6) fusible links of each type, size, and rating used on the project. Where required, furnish Greenheck Type

CR, CO, or Type C transition sleeves.

2.11. DUCT ACCESS DOORS

- A. Furnish and install adequately sized duct access doors at fire dampers, smoke dampers, air measuring devices, motor-operated dampers, duct smoke detectors, duct coils and other locations where indicated and required for duct access. Doors shall be the continuous piano-hinged type with approved latches and neoprene compression-type gaskets with 1 inch thick fiberglass double skin and shall be Ruskin Model ADH22, Air Balance, Inc., FSA-100 or as approved equal. Stiffen ductwork at door openings. Where doors are installed in insulated ductwork, provide equivalent insulation in the door assembly. Where access doors are installed in the fire-rated partitions, provide Fire Seal access doors as manufactured by Air Balance, Inc., or approved equal, UL approved, meeting the rating of the enclosure in which the access door is installed.
- B. Where duct access doors are installed in medium pressure ductwork, they shall be as manufactured by Ruskin, Type ADHP-3, or approved equal, with six latches continuous gasket and insulated core.
- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

2.12. SPIN-IN FITTINGS

- A. Furnish and install spin-in fittings where indicated on the contract drawings, Model SM-20G, as manufactured by General Environment Corporation, or an approved equal.

2.13. DUCT LINING (LOW PRESSURE DUCTWORK)

- A. All low pressure supply and return ductwork within 10 feet of air handling units, rooftop units, heating and ventilation units, make-up air units, and energy recovery ventilation units and as additionally shown on Contract Drawings, shall be lined on the interior for sound attenuation and thermal insulation.
- B. All low pressure ductwork within 10 feet of return or exhaust air fans and as additionally shown on Contract Drawings shall be lined on the interior for sound attenuation and thermal insulation.
- C. All internal duct lining for low pressure duct systems shall be provided with an interior galvanized perforated liner.
- D. Provide additional exterior insulation where required and as indicated in Division 23 Section, "HVAC Insulation".
- E. The lining insulation shall be 1 inch thick, 3.0 pcf density, Aeroflex plus Duct Liner Type 300, Owens Corning Quiet R Rotary Duct Liner, Manville, Knauf, or approved equal. The material shall be specifically designed for this application, shall have a black, fire-resistant coating, shall meet NFPA Standards 90A and 90B and shall have a UL Fire Hazard Classification of Flame Spread 25 or less and smoke developed of 10 or less. The black-coated surface shall face the air stream.
- F. All exposed edges and the leading edge of all cross joints of the liner shall be coated with

the same adhesive used to secure the duct liner to metal surface. All air stream surfaces shall be treated with EPA registered fungicide Foster 40-20. Coating shall meet ASTM D 5590 with 0 growth rating.

- G. The duct liner shall be adhered to the metal with 100 percent coverage of adhesive. Adhesive shall conform to Adhesive and Sealant Council Standards for adhesives for duct liner; ASTM C916, Type II (ASC-A-7001-A-1971). Adhesive shall be Foster 85-60, Childers CP-127 or approved equal.
- H. The duct liner shall be additionally secured with mechanical fasteners, which shall compress the duct liner sufficiently to hold it firmly in place. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1-1971, available from Sheet Metal and Air Conditioning Contractors National Association.
- I. All duct lining shall be installed in complete accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Liner Application Standard, First Edition and Green Guard Indoor Air Quality certification program requirements.
- J. Dimensions on drawings indicate inside clear opening of rectangular ductwork. Increase duct dimensions 2 inches each way for accommodating insulation on all shop or field-fabricated rectangular ductwork where lining is specified.

2.14. DUCT LINING (MEDIUM PRESSURE DUCTWORK)

- A. All medium pressure supply and return ductwork within 10 feet of air handling units, rooftop units, heating and ventilating units, make-up air units, and energy recovery ventilators and as additional shown on contract drawings shall be lined on the interior for sound attenuation and thermal insulation.
- B. All medium pressure ductwork within 10 feet of return air fans and as shown on Contract Drawings shall be lined on the interior for sound attenuation and thermal insulation.
- C. Provide additional exterior insulation where required and as indicated in Division 23 Section, "HVAC Insulation".
- D. All internal duct lining for medium pressure duct systems shall be provided with interior galvanized perforated liner.
- E. The insulation shall be 1 inch thick, 3.0 pcf density, Aeroflex plus Duct Liner Type 300, Owens Corning Quiet R Rotary Duct Lines, Manville, Knauf, or approved equal. The material shall be specifically designed for this application, shall have a black, fire-resistant coating, shall meet NFPA Standards 90A and 90B and shall have a UL Fire Hazard Classification of Flame Spread 25 or less and smoke developed of 10 or less. The black-coated surface shall face the air stream.
- F. All exposed edges and the leading edge of all cross joints of the liner shall be coated with the same adhesive used to secure the duct liner to metal surface. All air stream surfaces shall be treated with EPA registered fungicide Foster 40-20. Coating shall meet ASTM D5590 with 0 growth rating.

- G. The duct liner shall be adhered to the metal with 100 percent coverage of adhesive. Adhesive shall conform to Adhesive and Sealant Council Standards for adhesives for duct liner; ASTM C 916 (ASC-A-7001-A-1971). Adhesive shall be Foster 85-60, Childers CP-127 or approved equal.
- H. The duct liner shall be additionally secured with mechanical fasteners which shall compress the duct lines sufficiently to hold it firmly in place. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1-1971, available from Sheet Metal and Air Conditioning Contractors National Association.
- I. All duct lining shall be installed in complete accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Liner Application Standard, First Edition and Green Guard Indoor Air Quality certification program requirements.
- J. Dimensions on drawings indicate inside clear opening of rectangular ductwork. Increase duct dimensions 2 inches each way for accommodating insulation on all shop or field-fabricated rectangular ductwork where lining is specified.

2.15. STACKS AND BREECHING (CONDENSING BOILERS)

- A. The factory-built modular connector, manifold and breeching system shall be laboratory-tested and listed by Underwriters Laboratories, for use with building heating equipment which produces exhausted flue gases at a temperature not exceeding 550 degrees Fahrenheit (F) under continuous operating conditions and shall comply with UL-1738, ULC 5636, NFPA-54, and NFPA-211 when burning gaseous, solid or liquid fuels as described in NFPA 211. The breeching system shall be designed and installed to be gas and water tight and thus prevent leakage of combustion products into a building. The system shall be designed to compensate for all flue gas induced thermal expansions.
- B. Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category I, II, III, and IV appliances, or as specified by the equipment manufacturer.
- C. The double wall breeching shall have an inner gas carrying pipe of Type AL29-4C stainless steel for natural gas. Vent shall be listed for an internal static pressure of 15" w.g. and tested to 37" w.g. There shall be a nominal 1-inch fiber insulation between the walls. The outer jacket shall be Type 430 stainless steel. The materials and construction of the modular sections and accessories shall be as specified by the terms of the product's UL listing.
- D. The stack system shall be installed according to the manufacturer's installation instructions and shall comply with the codes and standards of the State of Delaware, International Mechanical Code, and applicable N.F.P.A. pamphlets. Stack termination height shall be sufficient to prevent re-entrainment into other building openings. Stack termination shall be minimum of 15 feet away from all building openings, intakes. All breeching stack terminations with a 15 foot radius of any building opening intake, or louver shall be extended 3 feet above the opening, intake or louver.
- E. Inner wall joints shall be designed with a male and female overlapping metal-metal connection to maintain condensate in the AL29-4C stainless steel. Proper ¼" per foot pitch must be maintained at all times and condensate should flow back toward the

appliance to the required number of drains. All inner wall conduit components shall be manufactured from AL-29-4C stainless steel. The joint closure system shall be an inner wall mechanical locking strap design. Joints shall not use screws or fasteners that penetrate inner conduit.

- F. When installed according to the manufacturer's installation instructions, the piping and its supporting system shall resist side loads (whether system is horizontal or vertical) at least 1.5 times the weight per foot of the piping. Wall supports shall support 40 feet of pipe with a factor of safety of at least four (4). Plate supports shall support (as verified by manufacturer testing) 200 feet of pipe in 6-inch through 20-inch ID sizes and 100 feet of pipe in 24-inch ID and larger sizes with a factor of safety of at least four (4).
- G. The entire breeching system from the equipment to termination, including all required accessories (ventilated roof thimbles, guy wires, storm collar, guy tensioners, expansion joints, discharge cone, supports, etc.), shall be from one manufacturer.
- H. The breeching shall be warranted against functional failure due to defects in material and manufacturer's workmanship for a period of fifteen years from date of installation. Drawings showing the actual layout and drawn to scale shall be provided by the manufacturer. The system shall be installed as designed by the manufacturer and in accordance with the terms of the manufacturer's 15-year warranty and in conjunction with sound engineering practice. The inner diameter for breeching and stacks shall be verified by the manufacturer's computations. The computations shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the inner pipe. The Contractor shall furnish the exact boiler model and operating characteristics to the factory representative. Operating characteristics shall include flue gas flow rate, BTU input, outlet temperature, local altitude, stack layout, and available external pressure at boiler or equipment outlet, etc., necessary to determine system operation at maximum and minimum levels of burner turndown range.
- I. Boiler breeching, as hereinbefore specified, shall be provided for all new fuel-fired equipment, including but not limited to boilers.
- J. General Electric RTV106 (aka Momentive) or Dow Corning 736 High Temperature Sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550°F.
- K. Boiler breeching shall be Type Saf-T Vent CI Plus as manufactured by Selkirk Metalbestos, Type CS Plus by Van Packer, Type SD by Schebler, or Type CG by Metal-FAB.

2.16. AIR TERMINAL DEVICES

- A. Furnish and install air supply, return, exhaust devices of sizes and capacities as scheduled on the drawings. Catalog numbers shown are Metalaire, Inc., products for equipment which have been found suitable for the application. Products of Tuttle & Bailey, Anemostat, Division of Hart & Cooley, Carnes, Titus, Price, Nailor, Krueger, or approved equal will be considered only if performance characteristics including throw, drop, pressure loss, sound pressure level, etc., are equal to or better than the performance characteristics of the specified products. All air devices shall be ADC certified. Ductwork behind registers, grilles and diffusers shall be given two coats of flat black

paint. Perimeter of all ceiling diffusers shall be caulked to provide a neat, aesthetic appearance.

B. Device Schedule:

AIR DEVICE SCHEDULE			
Device	Accessories		Finish
Supply Diffusers, Lay-in Tile			
Model 5000-A, Rectangular MetalAire Ceiling Diffuser, Throw as Indicated	Integral opposed blade damper		White baked enamel finish
	Removable core		
	Louvered face		
	All aluminum construction		
	Auxiliary panel for lay-in tile installation		
	Adjustable pattern deflector		
Supply Diffuser, Gypboard, Surface Mount			
MetalAire Model 5000-A, Rectangular Ceiling Diffuser, Throw as Indicated (Surface or Duct Mount)	Integral opposed blade damper		White baked enamel finish
	Louver face		
	All aluminum construction		
	Removable core		
	Adjustable pattern deflector		
Supply Register, Sidewall, Floor			
MetalAire Model V4004D, Sidewall Supply Register, Throw as Indicated (Surface or Duct Mount)	Integral opposed blade damper		White baked enamel finish
	All aluminum construction		
	22½ inch deflection blades		
	Double deflection spread & drop control		
Return/Exhaust, Transfer Register, Gypboard, Surface Mount			
MetalAire, Model RHD Rectangular Registers (Surface Mount)	Integral opposed blade damper		Off-white baked enamel finish

AIR DEVICE SCHEDULE		
	45 degree angled deflecting vanes	
	All aluminum construction	
Return/Exhaust Register Sidewall w/filters		
MetalAire Model SRHF Sidewall Return Register with Filter Housing	All steel construction	Off white electro-deposition finish
	45 degree angled deflecting vanes	
	Opposed blade dampers	
	Filter housing w/ 1 inch thick disposable filter	
	Hinged core	
	Provide return air filters racks and 1" thick filters where indicated.	
Return/Exhaust, Transfer Register, Lay-in Tile		
MetalAire, Model RHD Rectangular Registers	Integral opposed blade damper	Off-white baked enamel finish
	45 degree angled deflecting vanes	
	All aluminum construction	
	Auxiliary panel for lay-in tile installation	
	Provide return air filters racks and 1" thick filters where indicated.	
Supply Diffuser Round, High Capacity		
MetalAire Model 3100 Round Ceiling Diffusers	Air equalizing grids	Off-white baked enamel finish
	Integral opposed blade dampers	
	All aluminum construction	
	Volume control adjustment	

- C. Where air terminal devices are installed in duct collars or branches, furnish and install air extractors. Furnish and install control grids, volume dampers, and/or other accessories necessary to ensure uniform air flow across the terminal devices. Accessories shall be of

the same material as the terminal device. Install fixed blade terminals so that blades block the normal line of vision. Furnish three (3) of each type of removable key operators.

- D. Contractor shall determine frame and mounting type as per type of ceiling as shown on Architectural drawings.
- E. Noise Criteria: All air devices shall be sized and selected to limit maximum NC (noise criteria) levels to 30.

2.17. LOUVERS (FIXED BLADE)

- A. Furnish and install wall louvers of the size and capacity shown on the contract drawings. Louvers shall be Greenheck Model EHV-901 (high velocity wind driven rain) heavy gauge extruded aluminum stationary type louvers or approved equal. Louvers shall be stationary, dual module type consisting of a "front" louver with J-style blades and a "rear" louver with vertical rain resistant style blades. Louver frame shall be a total depth of 9 inches.
- B. Front louvers shall be drainable type fabricated from heavy gauge 6063-T5 aluminum extrusions of .081 inch nominal wall thickness. Blades shall be positioned at 37 degree and 45 degree angles, approximately 4.25 inches on centers. Rear louver shall be vertical rain resistant style, heavy gauge extruded 6063-T5 aluminum, 0.060 nominal thickness, positioned on approximately 1.5 inch blade spacing. Each louver shall be equipped with a frame and removable rear-mounted screen of flattened aluminum. Each factory assembled louver section shall be designed to withstand wind loadings of 25 psf. Louvers too large for complete factory assembly shall be built up by the installing contractor from factory assembled louver sections.
- C. Louvers shall be tested in accordance with AMCA 550-L, AMCA-540, and AMCA 550 (Certified High Velocity, Rain Resistant, and Impact Resistant Louver).
- D. Louvers shall be supplied with a factory Kynar finish applied after a thorough cleaning and preparation of the metal surface. A total dry film thickness of approximately 1.2 mils shall be provided. Custom color shall be as selected by Architect.
- E. Louvers shall be provided with ¼ inch x ¼ inch aluminum bird screens, factory-furnished and installed. Louver performance data shall be A.M.C.A. certified. All louvers shall be caulked weathertight around entire perimeter.

2.18. LOUVER BLANK-OFF PANELS

- A. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver
 - 1. Thickness: 2 inches (50mm)
 - 2. Metal Facing Sheets: Aluminum sheet, not less than .032 inch (.81mm) nominal thickness.
 - 3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than .080 inch (2.03mm) nominal thickness with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same finish applied to louvers.
7. Attach blank-off panels with stainless steel sheet metal screws.
8. Cover all unused openings in louvers.

2.19. OPEN END DUCTS (OED)

- A. Whether indicated on plans or not, all open-ended ducts shall be provided with a protective screen.
- B. All open-ended ducts shall be furnished with a 12 gauge ½ inch x ½ inch aluminum mesh screen. Screens shall be permanently installed in a removable frame, and the frame shall be attached to the open-ended duct in a neat, workmanship-like manner without any exposed edges or sharp surfaces.
- C. Screen shall be attached to a ¾ inch x 1/8 inch continuous galvanized perimeter frame. Install duct stiffeners greater than 16 inches in any direction at open-ended ducts.

2.20. DRIP PANS

- A. Furnish and install suitable watertight, aluminum drip pans where water or drain piping is routed over electrical switchgear, transformers, computers, elevator machine equipment, dry storage rooms, etc. Each drip pan shall have a 1 inch copper type M drain piped to discharge where shown on drawings; or, if not shown, to discharge over nearest available open drain. Size and arrangement shall be as approved by Engineer. Sides shall be minimum 1.5 inches deep.
- B. Drain pans shall be of 16 gauge welded construction. Provide drawings of typical drain pan construction for approval before construction. See Submittals in Division 01 Section, "Product Requirements".

2.21. DUCT SEALANTS AND ADHESIVES

- A. All ductwork shall be sealed, including low pressure exhaust systems. Transverse joints and longitudinal seams in duct systems shall be sealed with a duct sealant of the type specified hereinafter in Section 1, 2, or 3, or with a tape sealing system as specified in Section 4. Spiral lockseams are not longitudinal seams and do not require duct sealant. All seams and joints shall require duct sealant suitable for the pressure rating and installation application. All sealants shall exceed 500 hours without becoming brittle under ASTM-D572 test conditions (oxygen bomb), unless specified otherwise. No surface preparation or solvent cleaning shall be necessary to remove light coatings of oil and dust before applying sealant unless specified otherwise. Flanged joints shall be sealed according to Section 5. Construction joints that are not fully welded shall be sealed according to Section 6. Adhesive to secure insulation to metal surfaces shall be that specified in Section 7.

1. Assembly joints to be installed indoors or outdoors shall be sealed with Foster 32-19, Childers CP-146, United Duct Sealer WB, or equivalent, which is a water-based sealant formulated to withstand service temperatures from 20 degrees F to +200 degrees F. Sealant shall have a UL Classification marking with a flame spread of 15 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 31 square feet per gallon. Store and apply between 40°F (4°C) and 100°F (38°C); protect from freezing.
2. Assembly joints to be installed indoors shall be sealed with Foster 32-19, Childers CP-146, UNI-GRIP™ duct sealer or equivalent, which is a water-based (vinyl-acrylic polymer) sealant formulated to withstand temperatures from –20 degrees to +200 degrees Fahrenheit. Surfaces to be sealed should be clean, dry, and free from oil, grease, and dirt. Sealant shall be nonflammable (wet) and fire retardant. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 40 square feet per gallon.
3. Assembly joints shall be sealed with UNI-CAST® tape sealing system or equivalent, which is a combination of an adhesive activator and woven-fiber tape impregnated with a gypsum mineral compound. Modified acrylic/silicone activator (MTA-20 for indoor use) reacts exothermically with the tape to form a hard, airtight seal. Sealant shall be formulated to withstand temperatures from –40 degrees F to +200 degrees Fahrenheit. Combination of tape and MTA-20 adhesive shall have a flame spread and smoke developed of 0. Do not use for outdoors.
4. Flanged joints to be installed indoors shall be sealed with UNI-GASKET™ flange sealer or equivalent, which has a synthetic elastomer base and is formulated to withstand temperatures from –20 degrees F to +150 degrees F. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 80 square feet per gallon.
5. Where duct fittings are constructed with standing seam or spot-welded techniques, all construction joints shall be sealed with UNI-WELD™ metal cement or equivalent, which is composed of neoprene rubber, resins, and inert reinforcing material dispersed in a petroleum distillate. Sealant shall be formulated to withstand temperatures from –20 degrees F to +225 degrees F. Sealant shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, tested as applied in two 1/8 inch beads 8 inches on center.
6. Where insulation is to be secured to metal surfaces, the adhesive used shall be Foster 85-60, Childers CP-127, UNI-TACK™ duct liner adhesive or equivalent, which are water-based, vinyl-acrylic copolymer adhesives formulated to withstand temperatures from –20 degrees Fahrenheit to +200 degrees Fahrenheit. Adhesive shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 267 square feet per gallon. Adhesive shall

conform to ASTM C916, Type II.

- B. Manufacturers: Duct Mate, United McGill, MKT Metal Manufacturers, Semco, Elgen, Childers, Foster, or as approved equal.

2.22. AUXILIARY DRIP PANS

- A. Furnish and install suitable watertight, aluminum drip pans for all suspended air handling units, or air handling units installed on upper floor and/or attic. Each drip pan shall have a 1" copper type "M" drain piped to discharge where shown on drawings. Drain pan shall extend 3" beyond sides of air handling unit. Sides shall be minimum 1.5" deep.
- B. Drain pans shall be of 16 gauge welded construction. Provide drawings of typical drain pan construction for approval before construction. See Submittals, Division 23 Section, "Common Work Results for HVAC" and Division 01, Section, "General Requirements".
- C. Install U.L. 580 listed condensate float switch in auxiliary drain pan and wire to shut-down unit upon sensing water. All control and interlock wiring to be furnished and installed under Division 23 Section, "Instrumentation & Controls of HVAC & Plumbing Systems"

2.23. FILTER MEDIA DURING CONSTRUCTION

- A. Filter media installed during construction: Minimum MERV 8.

PART 3. EXECUTION

3.1. DUCT INSTALLATION REQUIREMENTS

- A. Coordinate ductwork with other work and install ducts at proper elevations and locations to maintain indicated ceiling heights and clearances. Provide all elbows, transitions, offsets, connections, and other fittings necessary to fit the work into place or to connect to equipment or diffusers. Method of duct support connection to structure and slabs shall be approved by Structural Engineer, and Shop Drawings shall be submitted.
- B. Substantially support ductwork with structural shapes, flat bars, or formed strap hangers securely attached to the building structure by means of bolts, clamps, or inserts. Support vertical ducts by angles attached to the duct and resting on the floor or supported by brackets or hangers attached to the building structure. Strap hangers shall be 16-gauge minimum galvanized steel formed under the bottom edge of duct. Use square ¼ inch thick washers tight against the bend on upper strap attachments to horizontal surfaces. Place all supports external to the ductwork and out of the air stream. Provide additional supports at coils and other concentrated loads. Arrange supports so that duct weight is not transmitted to ceilings, fans or other equipment.
- C. Prevent direct contact between ductwork and building surfaces or other equipment. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material. Provide flanged duct escutcheons at all exposed ducts that pass through walls, partitions, floors, and ceilings.
- D. Use galvanized (compatible) corrosion-resistant hangers, supports, brackets, and hardware.

- E. Furnish and install NFPA-approved duct connections where shown and at all connections to fans, air handling units, and similar rotating equipment. Use glass-reinforced neoprene fabric, roll-formed to sheet metal strips or flanges. Support adjacent ductwork to provide sufficient slack in the connection.
- F. See NFPA 90A, and latest publication of SMACNA. Prevent direct contact between ductwork and building surfaces or other equipment. The opening in the construction around the duct shall not exceed one-inch average clearance on all sides. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material capable of preventing the passage of flame and hot gases sufficiently to ignite cotton waste when subjected to the same NFPA 251 Time-Temperature Conditions required for fire barrier penetration. All exposed duct penetrations shall be finished with a sheet metal field erected flange escutcheon to form a neat appearance.
- G. Coordinate duct installation with the requirements of Division 23 Section, "Vibration Controls for HVAC, Plumbing & Fire Protection Equipment".
- H. Install in accordance with manufacturer's instructions.
- I. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- J. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- K. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- M. Use crimp joints, with or without bead, for joining round duct sizes eight (8) inches and smaller with crimp in direction of air flow.
- N. Use double nuts and lock washers on threaded rod supports.
- O. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- P. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork systems.

3.2. ACCESSORY INSTALLATION REQUIREMENTS

- A. Install accessories in accordance with manufacturer's instruction, NFPA 90A, and SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, duct detectors,

air flow monitoring stations, duct-mounted equipment, duct coils and elsewhere as indicated. Review locations prior to fabrication.

- C. Provide duct test holes where required for testing and balancing purposes. Review locations with Test and Balance Engineer prior to installation.
- D. Provide fire dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion-resistant springs, bearings, bushings and hinges.
- E. Demonstrate re-setting of fire dampers to Owner's representative.
- F. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment and supported by vibration isolators. Refer to Division 23 Section, "Vibration Control for HVAC and Plumbing Systems".
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum duct widths from duct take-off.
- H. Use splitter dampers only where indicated.
- I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- J. Install diffusers, registers, and grilles to ductwork with airtight construction.
- K. Check location of all air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangements.
- L. Install duct thermometer support flanges in wall of duct. Attach to duct with screws. Locate duct mounted thermometers, minimum 10 feet downstream of mixing dampers, coils or other devices causing air turbulence.
- M. Install remote - reading duct dial thermometers in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length. Mount control panel 60 inches above finished floor and label each dial thermometer.
- N. Install duct accessories according to applicable details shown in SMACNA's HVAC Duct Construction Standards Metal and Flexible for metal ducts.
- O. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- P. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- Q. Install fire dampers according to manufacturer's UL approved written instructions.
 - 1. Install fusible links in fire dampers. Label access doors according to equipment served.
- R. Adjust duct accessories for proper settings.

- S. Adjust fire for proper action.

3.3. DUCT LINING INSTALLATION REQUIREMENTS

- A. All portions of duct designated to receive duct liner shall be completely covered with duct liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black pigmented or mat faced surface of the duct liner shall face the airstream.
- B. Duct liner shall be adhered to the sheet metal. with 90 percent coverage of adhesive complying with requirements of ASTM C916. All exposed leading edges and transverse joints shall be factory coated or coated with adhesive during fabrication. Install perforated galvanized inner liner where indicated
- C. Duct liner shall be additionally secured with mechanical fasteners, either weld-secured or impact-driven, which shall compress the duct liner sufficiently to hold it firmly in place. Adhesive bonded pins are not permitted due to long term adhesive aging characteristics. Spacing of mechanical fasteners with respect to duct liner interior width shall be in accordance with SMACNA HVAC DGS. Maximum spacing for mechanical fasteners shall be as follows:

Velocity = 0 to 2,500 feet per minute (0 to 12.8m/s):

From transverse end of liner	3: (75mm)
Across width of duct	12 inches (300 mm) O.C.
From corners of duct	4 inches (100mm)
Along length of duct	18 inches (450mm) O.C.

Velocity = 2,501 to 5,000 feet per minute (12.8 to 25.4 m/s):

From transverse end of liner	3 inches (75m)
Across width of duct	6 inches (150mm) O.C.
From corners of duct	4 inches (100mm)
Along length of duct	16 inches (400mm) O.C.

- D. When air velocities exceed 4,000 fpm (20.3m/s), galvanized sheet metal nosing shall be applied to all leading edges of duct liner.
- E. Acoustical Duct Liner shall be cut to assure overlapping and compressed longitudinal corner joints.
- F. Upon completion of installation of duct liner and before operation is to commence, visually inspect the system and verify that the duct liner insulation has been correctly installed.
- G. Open all system dampers and turn on fans to blow all scraps and other loose pieces of material out of the duct system. Allow for a means of removal of such material.
- H. Check the duct system to ensure that there are no air leaks through joints.

3.4. STACKS AND BREECHING INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's instructions.

- B. Install in accordance with NFPA 54 (ANSI Z223.1) and NFPA 31.
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers, and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot (4 m) spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.
- E. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.
- F. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- G. Coordinate installation of dampers and induced draft fans.
- H. For double wall gas vents, maintain UL listed minimum clearances from combustibles Assemble pipe and accessories as required for complete installation.
- I. Install vent dampers, locating close to draft hood collar, and secure to breeching.
- J. Assemble and install stack sections in accordance with NFPA 82, Industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.
- K. Level and plumb chimney and stacks
- L. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- M. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.
- N. Provide maximum 2 feet of breeching to connect appliance to chimney.
- O. Do not install bull head tee at connections to equipment.

3.5. WATER HEATER INTAKE AND EXHAUST DUCT INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54 (ANSI Z223.1).
- C. Install flue pipes with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support flue pipes from building structure, rigidly with suitable ties, braces, hangers, and anchors to hold to shape and prevent buckling. Support vertical flue pipes, and stacks at 6 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

- E. Install concrete inserts for support of flue pipes and stacks in coordination with formwork.
- F. Pitch flue pipes with positive slope up from fuel-fired equipment to stack.
- G. Install vent dampers, locating close to draft hood collar, and secure to flue pipes.
- H. Assemble and install stack sections in accordance with NFPA 82, Industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.
- I. Level and plumb flue pipes and stacks
- J. Clean flue pipes and stacks during installation, removing dust and debris.
- K. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of flue pipes or stacks.
- L. Do not install bull head tee at connections to equipment.
- M. Provide and install condensate removal pipes and neutralizers per manufacturer's requirements.
- N. For condensing boilers provide and install flue pipe thermometers.

3.6. CLEANING

- A. Clean duct system and force air at high velocity through ducts to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- B. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- C. Ductwork shall be cleaned in accordance with "Duct Cleanliness for New Construction (SMACNA 2000)", and shall achieve a "Basic" cleanliness level.

3.7. LEAKAGE TESTS

- A. All low pressure sheet metal ductwork shall undergo leakage tests at 2 inch W.G. Tests shall be accomplished under this section and witnessed as specified under Division 23 Section, "Testing, Adjusting, and Balancing for HVAC and Plumbing".
- B. All medium pressure sheet metal ductwork shall undergo leakage tests at 5 inch W.G. Tests shall be accomplished under this section and witnessed as specified under Division 23 Section, "Testing, Adjusting, and Balancing for HVAC and Plumbing".
- C. Leakage from each duct system shall not exceed 5 percent for low pressure systems and 1 percent for medium pressure systems of the normal air handling capacity of the system. If the system ductwork is tested in sections, the leakage shall not exceed ½ of 1 percent of the CFM to be handled by that section, and the total leakage of the system shall not

exceed 1 percent of the total system CFM. Test pressure shall not exceed the pressure limits of the duct construction as defined in SMACNA High Pressure Duct Construction Standards. Repair all leaks which are audible, regardless of the leakage rate of the duct system as a whole, by remaking the entire defective joint or seam. Spot sealing of ducts in place will not be acceptable.

- D. All duct accessories, including but not limited to volume dampers, ATC sensors, duct detectors, duct coils shall be installed prior to duct leakage testing.
- E. Submit a complete report of the ductwork leakage tests to the Architect and include final approved copies in test and balance reports.
- F. Refer to Division 23 Section, "Carbon Monoxide Exhaust System". For "leakage testing" Division 23 Section, "Carbon Monoxide Exhaust System" for leakage testing associated with Carbon Monoxide exhaust ductwork.

3.8. DUCTWORK IDENTIFICATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. All ductwork shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color Code and System Identification shall comply with ANSI Standards.
- C. Marking shall be plain block letters, stenciled on ductwork (above and below ceilings) and shall be located near each branch connection and at least every ten feet on straight runs of ductwork. Where ductwork is aligned adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner as to be easily legible from the floor.
- D. Identify ductwork with plastic nameplates or stenciled painting. Identify with air handling unit identification and area served.
- E. Length of color field for ductwork shall be 32 inches. Lettering shall be minimum 3-1/2 inches high.

END OF SECTION

SECTION 238126 - VARIABLE REFRIGERANT VOLUME SPLIT SYSTEMS WITH HEAT RECOVERY (AIR COOLED SYSTEMS)

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 Variable Refrigerant Volume Split Systems with Heat Recovery.
- B. Related Sections include the following. List below only products and equipment for this Project that the reader might expect to find in this Section but are specified elsewhere. Verify that the Section titles listed below are correct for this Project's Specifications.
 - 1. Division 23 Section, "HVAC Piping, Fittings and Valves" for refrigerant piping materials.
 - 2. Division 23 Section, "HVAC Insulation" for refrigerant pipe insulation requirements.
 - 3. Division 23 Section, "Vibration Controls for HVAC, Plumbing, & Fire Protection Equipment" for isolation materials.
 - 4. Division 23 Section, "Instrumentation & Controls of HVAC & Plumbing Systems" for temperature control devices, and control wiring and control devices connected to indoor, outdoor and refrigerant distribution devices.
 - 5. Division 26 Section, "Disconnect Switches & Circuit Breakers" and circuit breakers for field installed disconnect switches.

1.3. DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EER: Cooling full load energy efficiency ratio.
- C. IEER: Cooling integrated (part load) energy efficiency ratio.
- D. High Temperature COP: Heating coefficient of performance at 42°F.
- E. Low Temperature COP: Heating coefficient of performance at 17°F.
- F. SCHE: Simultaneous cooling and heating efficiency.
- G. VRV: Variable Refrigerant Volume

1.4. SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.
- B. Product data for Variable Refrigerant Volume units specified, including the following:
 - 1. Dimension and plans and elevation drawings including field piping, required clearances and locations of all field connections.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance rating with system operating conditions indicated.
 - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 5. Filters with performance characteristics.
 - 6. Outdoor air cooled heat pump unit.
 - 7. Summary of all auxiliary utility requirements such as electricity, refrigerant piping, and condensate piping. Summary shall indicate quality and quantity of each required utility.
 - 8. Branch selector box data.
 - 9. Refnet data.
 - 10. ARHI 1230 certification including EER, IEER, high temperature COP, low temperature COP, and SCHE.
 - 11. Equipment selections de-rated to reflect scheduled data.
 - 12. VRV equipment certified installer's certificate.
 - 13. Wiring material product data and wiring layout for all systems: power, VRV control, control systems, interface to BMS and associated VRV equipment.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure for roof mounted units. Detail mounting and securing to concrete pads for grade mounted systems. Indicate coordinating requirements with roof membrane system or concrete pads and vibration isolation.
- D. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer installed and field installed wiring.
- E. Field Test Reports: Indicate results of manufacturer's startup and testing requirements. Submit copies of checklists.
- F. Maintenance Data: For equipment to include in the maintenance manuals specified in

Division 01.

- G. Warranties: Special warranties specified in this Section.
- H. Install factory certified documents indicating approval to install the VRV equipment.

1.5. SYSTEM DESCRIPTION

- A. Furnish and install where indicated, a variable capacity, heat recovery air conditioning system. System shall be a Variable Refrigerant Volume Series split system as manufactured by Daikin, Mitsubishi, Trane, Samsung, Johnson Controls, LG or approved equal. The system shall consist of multiple indoor units capable of cooling or heating, branch selector boxes, refrigerant joints to separate refrigerant flow between units and headers (refnets), a three pipe or two pipe refrigeration distribution system using PID control, and an outdoor unit. The indoor units shall be connected to the outdoor units utilizing the specialized piping joints provided by the equipment manufacturer. The outdoor unit shall be direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with fixed speed and variable speed inverter driven compressors using R-410A refrigerant. The outdoor unit may connect to a connected indoor capacity up to 130% of the outdoor unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be provided to provide optimum heating operation performance.
- B. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with one branch cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a BMS interface. Provide all interlock wiring between system controllers and building automation system.
- C. Branch cool/heat selector boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control cooling and heating downstream of the box to each individual heat pump unit. The box shall consist of electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the branch selector box and main processor and between the branch selector box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of electronic expansion valves ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels.
- D. Manufacturer shall have five years prior experience making similar equipment as described in this specification.

1.6. QUALITY ASSURANCE

- A. All equipment and systems shall be tested and certified in accordance with AHRI 1230 (Performance Rates of Variable Refrigerant Flow (VRF) Multi-Split Air Conditioning and Heat Pump Equipment) and bear the AHRI certification seal.
- B. Fabricate and label refrigeration system to comply with ASHRAE 15, Safety Code for Mechanical Refrigeration.
- C. Listing and Labeling: Provide electrically operated components specified in this Section

that are listed and labeled.

1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.
- D. Comply with NFPA 70 for components and installation.
- E. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
- F. The system shall be factory tested for safety and function.
- G. Coordination: Coordinate layout and installation of indoor units, outdoor units, refrigerant piping, branch selector boxes, refnets, and other appurtenances with piping and ductwork and with other installations.
- H. Contractor’s certified VRV equipment installer must be on site during installation of VRV system, refrigeration piping, control wiring, system controls and interface to BMS, and associated VRV equipment.
- I. Obtain all necessary permits for low voltage and power wiring for VRV system.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Deliver outdoor and indoor units as factory assembled units with protective crating and covering.
- B. Coordinate delivery of units in sufficient time to allow movement into building or on to roof as indicated.

1.8. WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
 1. Warranty Period: Compressors and Compressor Motor Contactors: Manufacturers standard, but not less than 6 years after date of Substantial Completion.

1.9. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following: Retain above for nonproprietary or below for semi proprietary Specification. Refer to Division 1 Section "Materials and Equipment."
 - 1. Daikin, Samsung, Johnson Controls, Mitsubishi, Trane, LG or approved equal.
- B. Basis of Design was a Daikin 3-pipe system. All scheduled capacities and efficiencies must be met. Cost of any electrical, piping, design, insulation, additional branch selector boxes, heat recovery boxes, refnets, or other changes associated with other approved manufacturers shall be included in the bid and shall be the responsibility of the Contractor. If manufacturer other than the Basis of Design is utilized and the same requires drains at branch selector boxes, Contractor must provide piping, insulation and if needed to condensate pumps at no additional cost to the Owner. This includes power requirements for condensate pumps.

2.2. OUTDOOR UNITS – AIR COOLED

- A. The outdoor unit is designed specifically for use with variable refrigerant volume system components. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, refrigerant regulator and all components for a complete functioning system.
- B. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
- C. The following safety devices shall be included on the outdoor unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
- D. Unit Cabinet: The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- E. Fan: The unit shall have one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units. The fan shall be a vertical discharge configuration and the motor shall

have inherent protection and permanently lubricated bearings and be mounted.

- F. Condenser Coil: The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film and pipe plates shall be treated with powdered polyester resin for corrosion prevention.
- G. Compressor: Unit shall contain both fixed speed scroll and variable speed inverter scroll compressors. Inverter scroll compressors shall be variable speed (PAM inverter) controlled which shall be capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read and calculated. Each non-inverter compressor shall also be of the hermetically sealed scroll type. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value. Compressors shall be spring mounted to avoid the transmission of vibration.
- H. Surge Protection: Provide unit with DIN Rail Plug-in Surge Protection for each compressor unit installed for all telecom and control circuits. Surge protection shall be factory or field installed per manufacturer's recommendations. Surge protectors shall be model DLA as manufactured by Citel or approved equal. Units shall be listed in accordance with UL497B.

2.3. BRANCH SELECTOR/HEAT RECOVERY BOX

- A. Branch selector (BS)/heat recovery boxes shall be located as shown on the drawing. The BS/heat recovery box shall be furnished with at least 5 electronic expansion valves (EEV's), refrigerant control piping and electronics to facilitate communications between the BS/heat recovery box and main processor and between the BS/heat recovery box and indoor units. The BS box shall control the operational mode of the subordinate indoor units. The use of five EEV's shall control the direction of refrigerant flow and ensure continuous heating during defrost, no heating impact during changeover and reduced sound levels. The branch selector/heat recovery boxes shall be designed specifically for use with heat recovery system components. These selector/heat recovery boxes shall be factory assembled, wired, and piped and shall be run tested at the factory. Unit Cabinet shall have a galvanized steel plate casing. Each cabinet shall house a liquid gas separator and contain a tube in tube heat exchanger. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene. Each circuit shall have at least one branch selector/heat recovery box to facilitate simultaneous heating and cooling in the system. Multiple indoor units may be connected to a branch selector/heat recovery box provided they are within the capacity range of the branch selector. The unit electrical power shall be as scheduled on the Contract Drawings. Each branch selector shall support up to four heat pump units, each served by dedicated refrigerant suction and liquid piping. Each heat pump unit shall be able to individually operate in heating or cooling mode.

2.4. INDOOR UNITS

- A. Ceiling Cassette Indoor Unit - The unit shall be completely factory assembled and wired.

The casing shall be galvanized sheet with grey heat insulation. This unit shall fit in the ceiling and have the capability of attaching a branch supply duct as well as a fresh air duct. The evaporator fan shall be an assembly with a high performance, fan direct driven by a single motor. The fans shall be statically and dynamically balanced and run on permanently lubricated bearings. The indoor unit shall have an adjustable air outlet system offering 4-way air flow, 3-way air flow, or 2-way air flow. The auto air swing vanes shall automatically swing up and down for uniform air distribution. Return air shall be filtered by a long-life filter to provide approximately, 2500 hours of use in a normal office environment before cleaning. The indoor unit shall be covered with a flat panel which protrudes only 1 inch below the ceiling to provide a neat and clean installation. The coils shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tubes joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan shall extend under the coil and piping. An integral drain pan pump capable of lifting condensate 22 inches shall be provided. An integral booster heater shall not be provided to supplement the unit during the heating mode. The unit electrical power requirements shall be as scheduled on the contract drawings. Furnish with condensate overflow float switch that will shut down unit should a high condensate level condition be sensed.

2.5. CONTROL SYSTEM

- A. The control system shall consist of multiple microprocessors interconnected by a single non-polar two wire multiplex transmission system. Wiring shall be daisy chained from unit to unit direct. NO SPLICES. One microprocessor shall be factory wired and located within each indoor unit. It shall have the capability of sensing return air temperature and indoor coil temperature; receive and process commands from the remote controller. The microprocessor within the wall mounted remote controller shall provide automatic cooling and heating system changeover; display set point and room temperature; a 24 hour on/off timer so that automatic operation can be set on the timer at one hour intervals from one to twenty-four hours; have self-diagnostic function display; check mode for memory of most recent problem; and provide on-off and system/mode function switching. The heating system shall be controlled so that only warm air is discharged whenever the fan speed exceeds the very low (VLO) speed. Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room. The control voltage between the indoor units and the outdoor unit shall be 16 volts D.C. 16 VDC shall be generated from the outdoor unit microprocessor board. The system shall be capable of automatic restart when power is restored after power interruption. System shall include twenty function self-diagnostics including total hours of compressor run time. Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads. Indoor units shall use PID control to control superheat.
- B. System Controller: Control system shall include a central controller for user interface with system. Controller shall include a Liquid Crystal Display (LCD) touch screen capable of controlling up to 16 outdoor units and 64 indoor unit groups (maximum 128 indoor units).
- C. System Controller shall be able to control the following functions:

1. On/Off selection for each indoor unit group or zone that is defined with several indoor unit groups.
 2. Setpoint adjustment for each indoor unit group or zone.
 3. Fan speed adjustment for each indoor unit group or zone.
 4. Heat/cool/fan mode selection for each indoor unit group or zone.
 5. Automatic changeover and antifreeze/overheat protection.
 6. Forced shutdown terminals.
 7. Priority settings for restriction of local access for start/stop, heat/cool mode and setpoint adjustment (at local remote controllers).
 8. Setpoint limitation in both heating and cooling mode.
 9. Weekly schedule with start-up and shut off times, temperature settings, and operation modes; 16 operations/each day can be set in one schedule, and 8 different schedules are available for special working days, holidays, or period of non-use.
 10. Actual time display and setting.
 11. Reset ability for malfunction codes and filter maintenance warning.
 12. Maximum 13 months back up power supply to maintain the memory.
 13. Non systems units (e.g. energy recovery ventilator) can be started/stopped and general alarm/status reported using Digital Input or Digital Input/Output units, including interlock program.
 14. Controller must be BACnet compatible.
- D. Controller shall provide control transformer for 24 VAC supply voltage for controllers as required.
- E. Provide interface devices as required to interface to Building Automation System. ATC Interface shall allow monitoring of all points indicated on the point list.
- F. Furnish the controls with the necessary interfaces to communicate via BACnet/IP or LonWorks to a building automation system. Exact protocol to be determined by the ATC subcontractor and VRV installing contractor.
- G. All inputs and outputs on the manufacturer's controller shall be viewable via the interface.
- H. All set points and schedules shall be editable via the interface by the building automation system.
- I. In addition to standard inputs/outputs provide additional input/outputs as required to

accomplish sequence of operation and items listed on point list.

- J. The manufacturer shall be responsible for assisting and participating in the integration of the equipment into the building automation system and shall provide programming support, testing, verification, and on site personnel as required.

2.6. WIRING

- A. All wiring devices and wire/cable shall be approved for the proposed purpose.
 - 1. Communication cable shall be indicated for use in the data sheet
 - a. Bacnet
 - b. Lon
 - c. RS-232
 - d. RS-485 for VRV Loop wiring
 - 2. All wire/cable shall be installed per VRV and wire/cable manufacturers' data sheets.
 - 3. All wiring devices and wire/cable shall be labeled by UL or approved listing agency.
- B. All installation contractors must have one person on site with five years experience in the trade during the complete installation process.
- C. All wiring shall be installed per National Electric Code, BICSI and all other codes.
- D. All wiring shall be installed in a neat, best and most workmanlike manner using the proper hangers and the protection of wiring in the installed method used.
- E. Installing contractor must supply an electrical permit for record purposes before work begins.
- F. Equipment supplier equipment shall not be installed as a single point of failure by the control contractor.
- G. Equipment manufacturer shall supply control contractor with a pre-wired and tested control NEMA 1 enclosure with gateway, power supply and terminal strips. A complete set of wiring diagrams for the interface must be submitted and included in the O&M manuals.
- H. Control panel power shall have a separate 120 volt single phase circuit with no other load on the circuit.

2.7. VRF/VRV SYSTEMS BACNET GATEWAY

- A. The VRF/VRV Systems BACnet™ Gateway shall be capable of monitoring up to 256 indoor units and 64 outdoor units through its embedded web browser. The BACnet Gateway shall be capable of controlling 92 indoor units and 8 outdoor units through its embedded web browser with third-party Building Automation Systems interface. The BACnet Gateway provides multiple energy management schemes and integrates with

third-party Building Automation Systems.

2.8. FILTERS

- A. In addition to the washable filters provided with each indoor unit, provide two (2) sets of spare additional washable filters for every indoor unit on the project. Provide correspondence documenting filters have been turned over to Owner at Substantial Completion.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine space for compliance with requirements for conditions affecting installation and performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Mount indoor and outdoor units as detailed on contract drawings and according to manufacturer's written instructions. For outdoor unit furnish and install structural I-beam below each unit and mount on vibration isolation material.
- B. Install all interlock and control wiring between indoor units, outdoor units thermostats, and condensate pumps.
- C. Supply initial charge of refrigerant and oil as required.
- D. Install indoor ceiling cassettes and ducted units on vibration isolators.
- E. Install outdoor units on concrete pads or on roof curbs as indicated on drawings.
- F. Comb out fins on condensing unit where deformed or bent. Replace or repair broken fins.
- G. Install condensate lift pumps, float switches, alarm, unit shut down wiring and detection block units per manufacturer's recommendations.
- H. For wall mounted units field wire power wiring, alarm circuits, control cable, safety circuit connection, alarm, and condensate pump. Condensate pump shall be powered from indoor unit power wiring. Coordinate condensate pump electrical characteristics with indoor unit electrical characteristics.
- I. Install system controller and interlock all indoor and outdoor units.
- J. Install lockable caps on all outdoor unit refrigerant service valves to prevent tampering.
- K. All final pipe lengths shall be submitted to VRV manufacturer to verify compliance with manufacturer's requirements.
- L. Install all refrigerant piping per manufacturer's requirements without deviation.
- M. Label and identify all indoor units, outdoor units, piping, and branch selector boxes.

- N. Install refnets and Y-fittings with manufacturers' required unobstructed distances upstream and downstream of the same.
- O. Submit pressure test reports and vacuum test reports as informational submittals.
- P. Install all branch selector boxes with manufacturer's required clearances. Also branch selector boxes shall be installed level per manufacturer's requirements.

3.3. CONNECTIONS

- A. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
 - 2. Refrigerant Piping: conform to applicable requirements of Division 23 Section, HVAC Piping, Fittings, and Valves.
 - 3. Install refrigerant piping, refnets, Branch selector boxes, insulation, and control wiring as required by the manufacturer.
 - 4. Install isolation valves on all three pipes between outdoor unit and branch selector boxes.
 - 5. Install isolation valves on both pipes at every indoor unit.
- B. Electrical: Conform to applicable requirements in Division 26 Sections.
- C. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4. COMMISSIONING AND MANUFACTURER'S FIELD SERVICES

- A. Verify that installation is as indicated and specified. Provide factory authorized start-up and training.
- B. Complete manufacturer's installation and startup checks and perform the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to compressor, air cooled condenser coil, and fans.
 - 3. Verify that clearances have been provided for servicing.
 - 4. Check that labels are clearly visible.
 - 5. Clean condenser and inspect for construction debris.

6. Verify wiring is installed per VRF installation manual requirements
 - a. Grounds
 - b. Shielding
 - c. Prior to applying power perform and document end to end continuity test for each wire in the communication cable.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Adjust vibration isolators.
10. Verify all piping and branch selector boxes are insulated.
- C. Start unit according to manufacturer's written instructions.
 1. Complete startup sheets and attach copy with Contractor's startup report.
 2. Start-up units in close coordination with testing/balancing.
- D. Check and record performance of interlocks and protection devices; verify sequences.
- E. Operate unit for an initial period as recommended or required by manufacturer.
- F. Calibrate thermostats and humidity sensors.
- G. Check internal isolators.
- H. Start refrigeration and measure and record the following:
 1. Coil leaving air, dry and wet bulb temperatures.
 2. Coil entering air, dry and wet bulb temperatures.
 3. Refrigerant suction/discharge pressures.
 4. Indoor and outdoor unit amperage, voltage, and watts.
 5. Fan Rotation and RPM.
 6. Condensate pump operation.
 7. Condensate overflow safety switch operation.
 8. System controller operation.

3.5. VRF INSTALLATION SUPPORT

- A. The authorized manufacturer's representative shall include installation support for the project as specified in this section by means of a dedicated technical VRF support specialist.

- B. This project support shall be completed by an employee whose sole responsibility is to provide direct technical support for the VRF system. Sales staff or other roles are not permitted to provide these duties.
- C. The VRF support specialist must be available for a kick off meeting prior to work being started. This meeting should include the installing contractor, engineer, controls contractor, owner (or owner's representative) and general contractor.
- D. This meeting shall cover the following items:
 - 1. Review installation best practices for the VRF manufacturer.
 - 2. Review mechanical drawings and VRF system layout.
 - 3. Provide contact information for support during the project.
 - 4. Review integration requirements and mapping of points with ATC sub-contractor.
- E. Project support by the manufacturer's representative during the project shall include the following:
 - 1. Provide periodic onsite technical support for the installation contractor during the project.
 - 2. Review as-built information provided by the Mechanical Contractor.
 - 3. Provide documented reports and recommendations to the installing contractor.
- F. The manufacturer's representative shall monitor progress of the installing contractor and support set up of the VRF system prior to system start-up.
- G. The mechanical contractor shall provide all functions of the installation of the VRF system but not limited to the following:
 - 1. Piping per manufacturer's recommendations within the design software guidelines furnished by the manufacturer's representative.
 - 2. Wiring per the manufacturer's recommendations.
 - 3. Brazing with nitrogen per manufacturer's recommendations.
 - 4. Pressure testing to 550 psi pressure test for 24 hours. This must be documented and verified by the VRF support specialist from the manufacturer's representative.
 - 5. Evacuation of the system to 500 microns. This must be documented and verified by the VRF support specialist from the manufacturer's representative.
 - 6. Providing as-built piping information throughout the project must be documented and verified by the VRF support specialist from the manufacturer's representative. This is necessary to provide accurate refrigerant charge to be

added by the installing contractor.

7. Proper set up of the VRF system addressing.
- H. Start-up assistance for the installing contractor shall be provided by the VRF manufacturer's representative with the following guidelines:
1. The manufacturer's representative shall assist with starting the system and verifying that all VRF equipment is communicating properly and operating within the pressure and temperature guidelines of the VRF manufacturer.
 2. The manufacturer's representative must compile 1 hour of operational runtime data per system during this start-up.
 3. The manufacturer's representative will not be responsible for troubleshooting wiring, installation of any components, evacuation or pressure testing of the systems.

3.6. DEMONSTRATION

- A. Engage a factory authorized service representative to train Owner's maintenance personnel as specified below:
1. Review data in the maintenance manuals. Refer to Division 01 Section, Contract Closeout.
 2. Review data in the maintenance manuals. Refer to Division 01 Section, Operation and Maintenance Data.
 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

3.7. TRAINING

- A. The Variable Refrigerant Volume Split System manufacturer shall include in his bid, provisions for additional training at the company's regular school or training center. The VRV manufacturer shall include in his bid all costs associated with sending two (2) individuals to the VRV manufacturer's school for a period of not less than one (1) week. This training is in addition to the aforementioned training required under the General Provisions.
- B. The training time period shall be coordinated with the College's Facility Engineer. The schedule training period shall be arranged at the owner's convenience.
- C. Cost shall include all training material, instruction books, and two copies of video tape with sound DVD of training session.
- D. Upon completion of the work, the Contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on the operation of the VRV split system for a period of not less than four (4) four (4) hour days. All training shall be by the VRV split system manufacturer and shall utilize specified

manuals and as-built documentation.

- E. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
 - 3. Review data in maintenance manuals. Refer to Division 01 Section, Contract Closeout.
 - 4. Review data in maintenance manuals. Refer to Division 01 Section, Operation and Maintenance Data.
 - 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

PART 1. GENERAL

1.1. GENERAL

- A. For general mechanical requirements, see Division 23 Section, Common Work Results for HVAC and Division 01, General Requirements.
- B. Industrial exhaust system for carbon monoxide removal shall be constructed with materials recommended herewith and shall be installed in a permanent and workmanlike manner.
- C. Interior of all ducts shall be smooth and free from obstructions with all joints, fittings, and connections welded air tight. Duct construction shall be Class II. All duct construction shall be in accordance with the references hereinafter specified.
- D. All duct sizes shown are net inside clear dimensions. Unless otherwise indicated size runouts, drops, and connections to fan, disappearing exhaust units and other equipment to the full size of the equipment connection.
- E. Minor changes may be made in duct sizes where required to fit the available space, provided the indicated net free area and approximate aspect ratio are maintained.
- F. Smoothly transition all ductwork to prevent excessive or unnecessary turbulence or pressure loss.
- G. All exposed ductwork in finished areas shall be painted in color as selected by Architect/Engineer. All ductwork requiring paint shall be constructed of paint grade material with a paintable surface.

1.2. REFERENCES

- A. ACGIH - Industrial Ventilation, A Manual of Recommended Practice.
- B. AMCA 99 - Standards Handbook.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- E. AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.
- F. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Sheet Articles.
- G. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- H. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- I. AASTM A 527 - Steel Sheet, Zinc Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

- J. ASTM A 569 - Steel, Carbon (0.15 maximum percent), Hot-Rolled Sheet and Strip, Commercial Quality.
- K. AWS D9.1 - Welding of Sheet Metal.
- L. MNB PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.
- M. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying.
- N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- O. SMACNA - Round Industrial Duct Construction Standard.
- P. SMACNA - Rectangular Industrial Duct Construction Standard.
- Q. UL 181 - Factory-Made Air Ducts and Air Connectors.
- R. UL 214 - Test for Flame Propagation of Fabrics and Films.

1.3. QUALITY ASSURANCE

- A. Fans
 - 1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.
 - 3. Fabrication: Confirm to AMCA 99.

1.4. REGULATORY REQUIREMENTS

- A. Products requiring electrical connection: Listed and classified by Underwriters' Laboratories, Inc., suitable for the purpose specified and indicated.

1.5. ALTERNATES

- A. Refer to Division 01 Section, Alternates - Alternates for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. CARBON MONOXIDE REMOVAL SYSTEMS AND ACCESSORIES

- A. Flexible Tubing for Gasoline Engines
 - 1. Shall be Car-Mon type NU, AQC Dust Collection Systems, or approved equal, fabricated entirely of neoprene material and shall contain no fabric or wire supports. Complete assembly shall be crush-proof neoprene tubing. It shall be

fabricated using a vacuum mandrel forming process with a precision-patterned spiral convolution.

2. Tubing wall thickness shall be uniform throughout. The tubing shall resist kinking and collapsing and shall return to its original shape after being crushed or compressed. Exhaust adapters, flanges or other fittings shall be attached to the tubing at the factory. Field assembly is not acceptable.

B. Flexible Tubing for Diesel/Truck Engine

1. Shall be High Temperature Polymeric Tubing and be Car-Mon type HTX, AQC Dust Collection Systems, or approved equal of an abrasion-resistant fire retardant fabric, utilizing a high tensile strength weave, heat-resistant cloth base that is process saturated with specially formulated polymeric resins and heat cured to withstand continuous exposure to exhaust air temperatures within the tubing up to 665 degrees F interior and exterior. The tubing wall shall be two ply, triple overlap construction and shall be complete with a bonded scuff strip to provide additional abrasion resistance.
2. The tubing shall have an interior spring steel wire reinforcing spiral encased within the fabric lamination. Exhaust adapters, flanges or other fittings shall be attached to the tubing at the factory. Field assembly is not acceptable. Tubing shall be 5 inches in diameter by 8 feet long.

- C. Overhead Tubing Storage Reels: Provide and install overhead electric tubing storage reels of the size, outlet fitting diameter, tubing lengths, tubing diameter and electrical characteristics as shown on the contract drawings. Tubing storage reel shall be designed for use with Car-Mon HTX, AQC Dust Collection Systems, for diesel engines, or approved equal. The frame shall be welded construction using 2 x 2 x 1/8 square tubular steel with 12 gauge end plates, and airtight rotating cylinder with a recessed inlet fitting to which the flange mounted flexible tubing will be bolted. The assembly shall be driven by a 1/6 H.P. motor (115 volt) 1 phase/60 HZ with a sprocket and chain drive. A remote mounted push button station shall be provided with each unit and wired by the electrical subcontractor. Units shall be Car-mon series TSR-P, AQC Dust Collection Systems, or approved equal. Each unit shall be finished in a baked enamel finish.

- D. Contractor shall provide to Owner seven (7) additional 4-inch diameter flexible hose for extending length for all gasoline exhaust units. Extension tubing shall be identical to that specified for gasoline engines, shall be 10 feet in length and shall be provided with all adapters necessary to attach to disappearing floor exhaust units.

- E. Contractor shall provide to Owner two (2) additional 5-inch diameter flexible hose for diesel/truck engine exhaust unit. Extension tubing shall be identical to that specified for diesel engines, shall be 10 feet in length and shall be provided with all adapters necessary to attach to disappearing floor exhaust unit.

- F. Dual Exhaust Adapter: Contractor shall provide a Car-Mon T series, AQC Dust Collection Systems, or approved equal dual exhaust adapter for use with all gasoline engine exhaust units. Unit shall consist of slotted collar to fit tail pipe adapter. Two 5 feet long, 3-inch diameter flexible tubes shall be provided of the same material as that specified for gasoline engines. Two stainless steel tapered cone adapters shall be

provided with unit.

2.2. CARBON MONOXIDE EXHAUST FANS (INDUSTRIAL EXHAUST FANS)

- A. Carbon Monoxide Exhaust Fans shall be Arrangement 10, single width, single inlet, belt driven centrifugal backward inclined fans. Fans shall be Car-Mon centrifugal backward inclined fans with rotation and discharge as indicated on contract drawings. All fans shall be rated in accordance with AMCA standard 210 and shall carry the AMCA certified ratings seal.
- B. Fans shall be AMCA Class I or Class II construction, with heavy gauge housings. The entire fan shall be completely coated inside and out with red heresite phenolic resin corrosion protective coating. Every fan shall be individually tested prior to shipment.
- C. Housing shall be minimum 14 gauge and shall contain formed and welded corners fully caulked between housing and frame with non-hardening caulk. Housing shall be assembled with self-locking flange nuts and stud mounted with no bolts in the airstream. Inlet side of the housing shall be supported on the fan base in addition to motor compartment section. Bearing supports shall be minimum 3/16 inch structural angles and motor base shall be adjustable from exterior of the fan. OSHA belt guard shall be provided and shall have provisions for tachometer measurement.
- D. Wheel shall have welded blades with welds on the stress side of the blades. Any balancing weights shall be outside of the airstream part of the wheel, not on the blades. No nuts or bolts shall protrude into the airstream part of the wheel. Wheel shall be removable and shall have no greater than 3/32 inch running clearance between the wheel shroud and the inlet cone. Shaft shall be turned type and completely coated with asphaltic coating for corrosion protection and easy wheel removal. Shaft shall have a maximum of 0.001 inches per foot of run-out tolerance.
- E. Bearings shall be self-lubricating cast frame steel ball type. Stamped frame bearings will not be acceptable.
- F. Drives shall be variable pitch double groove type with matched belts and rated at 150 percent of motor load capacity. Provide belt and drive guard. Additional set of belts to be turned over to the owner upon final acceptance.
- G. Motor shall be ODP continuous duty industrial grade with accessible wiring boxes and shall be manufactured by a major domestic motor manufacturer. All motors shall be premium efficiency motor as indicated in Division 23 Section, Common Work Results for HVAC of these specifications.
- H. All fans shall be provided with belt guards per OSHA requirements, flanged outlets, scroll access door and drain fitting in scroll fans shall be provided with aluminum mesh inlet screen, vibration isolators, and weather cover. Provide NFPA-90 approved flexible connections on inlet and outlet of fans. Fans shall be installed with proper inlet and outlet conditions to minimize system effect as shown on contract drawings.

2.3. DUCTWORK AND DUCT ACCESSORIES

- A. Material
1. Above-grade carbon monoxide ductwork shall be stainless steel ducts, ASTM A 167, Type 316 suitable for 4 inch medium pressure class.
- B. Ductwork
1. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible 4-inch Pressure Class Round Industrial Duct Construction Standard and Rectangular Industrial Duct Construction Standard and ACGIH Industrial Ventilation Manual except as indicated.
 2. Construct T's, bends, and elbows with radius of not less than 1½ times width of duct on centerline.
 3. Increase duct sizes gradually, not exceeding 25 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 4. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Prime coat welded joints.
 5. Joints: Minimum 4-inch (100mm) brazed, or electric welded to AWS 9.1. Prime coat welded joints.
 6. Provide standard 45 degree lateral wye branch fittings unless otherwise indicated.
 7. Use double nuts and lock washers on threaded rod supports.
 8. All exterior industrial exhaust ducts shall be constructed of Type 316 stainless steel.
 9. The following metal thickness shall be supplied:

Diameter Of Straight Ducts Us Standard Gauge For 316 Stainless Steel Ducts
 1. To 8 inches 20
 2. Over 8 inches to 18 inches 18
 3. Over 18 inches to 30 inches 16
 4. Over 30 inches 14
 10. All motor-operated dampers located in stainless steel ductwork shall be constructed of Type 316 stainless steel. All motor-operated dampers shall be provided by the ATC subcontractor and installed by the Mechanical Contractor.
 11. Longitudinal joints of ducts shall be continuously welded with seams up.
 12. Girth joints of duct shall be made with inner lap in direction of air flow, with 1 inch lap, diameters to 19 inches, and 1-1/4 inch laps for diameters over 19 inches. All joints shall be continuously welded.
 13. Elbows and angles shall have a centerline radius of 2.5 pipe diameters. Construct

elbows 6 inches or less in diameter of at least five sections, over 6 inches in diameter of seven sections. Prefabricated elbows of smooth construction may be used. Angles shall be pieced proportionately. Prefabricated elbows shall be industrial duct fittings manufactured by United McGill or as approved equal.

14. Hoods must be free of sharp edges or burrs and reinforced to provide necessary stiffness.
 15. All welds shall be by gas fusion using rods of similar material.
 16. Hangers shall be Type 316 stainless steel hangers and support spacing shall be in accordance with SMACNA's standards for round industrial ducts.
 17. Connect duct to fan inlet with split sleeve drawband at least one pipe diameter long, but not less than 12 inches.
 18. Transitions in mains and sub-mains to be tapered; taper 5 inches long for each 1 inch change in diameter. Transitions shall be eccentric: Flat on bottom.
 19. All branches shall enter main at the large end of the transition at an angle not to exceed 30 degrees. Connect branches only to the top or sides of the main with no two branches entering diametrically opposite.
 20. Provide dead-end caps within 6 inches from last branch of all mains and sub-mains.
 21. Provide access openings or cleanouts every 10 feet and near each elbow, angle or duct junction in horizontal sections, except for non-corrosive gases and vapors containing no particulate matter.
 22. Support ducts sufficiently to place no load on connecting equipment and to carry weight of system if plugged with material. Maximum supporting interval 12 feet for 8-inch or smaller ducts, 20 foot intervals for larger ducts.
 23. Provide 6-inch minimum clearance between ducts and ceiling, wall or floors.
 24. Where blast gates are used for adjustment of system, place near connection of branch to main. Provide means of locking after adjustments have been made. Butterfly-type dampers shall not be permitted.
 25. Where state or local laws conflict with above specifications, the more stringent regulation shall be followed. Any other deviation must be approved before installation.
- C. Flexible Connections: UL 214 listed, fire-retardant chloroprene or chlorosulfonated polyethylene impregnated fabric, minimum density 36 ounces per square yard, approximately 6 inches wide, crimped into metal edging strip.
- D. Blast Gates: Full collar of steel with galvanized steel side.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- C. Install fans with resilient mountings and flexible electrical leads.
- D. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum one-inch (25mm) flex between ductwork and fan while running.
- E. Provide pitot tube openings where required for testing of systems, complete with meal cap with spring device or screw or ensure against air leakage.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

3.2. TESTING

- A. TESTING: Measure the air flow in the system with a standard pitot tube to determine whether it is functioning in accordance with design specification. All branch ducts shall be tested to assure design air flow rates as scheduled on Contract Documents. Static pressure profiles shall be conducted at all fan systems as indicated in Division 23 Section, Testing Adjusting & Balancing for HVAC & Plumbing.

3.3. LEAKAGE TESTS

- A. All sheet metal ductwork shall undergo leakage test at 3 inches WG. Test shall be accomplished under this section and witnessed as specified under Division 23 Section, Testing Adjusting & Balancing for HVAC & Plumbing.
- B. Leakage from each duct system shall not exceed 1 percent for medium pressure of the normal fan capacity of the system. If the system ductwork is tested I sections, the leakage shall not exceed ½ of 1 percent of the CFM to be handled by that section and the total leakage of the system shall not exceed 1% of the total system CFM Test pressure shall not exceed the pressure limits of the duct construction as defined in SMACNA High Pressure Duct Construction Standards. Repair all leaks which are audible, regardless of the leakage rate of the duct system as a whole, by remaking the entire defective joint or seam. Spot sealing of ducts in place will be unacceptable.
- C. Submit a complete report of ductwork leakage test to the Architect/Engineer and include final approved copies in Test and Balance Reports.

END OF SECTION

SECTION 260500 - COMMON WORK RESULTS 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. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this Division affected by Alternates.

1.3. SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Foam duct sealant.
 - 4. Grout.
 - 5. Plywood backboards.
 - 6. Protective wire guards.
 - 7. Common electrical installation requirements.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered.
- E. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- F. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

- G. Coordinate the work under Division 26 with the work of all other construction trades.
- H. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.

1.4. CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 26 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:
 - 1. A list of not less than five comparable projects which the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership in trade or professional organizations where required.
 - 5. Copy of Master Electrician's License.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.
- D. Supervisory Qualifications: The electrical work on the project shall be under the direct supervision of a licensed Master Electrician.
- E. Qualifications of Installers:
 - 1. For the actual fabrication, installation, and testing of the work, shall use only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the installation recommendations of the manufacturers of the specified items.
 - 2. Utilize a full time project foreman in charge of all electrical work. This person shall be fully qualified and experience in such work and shall be available, on site, at all times during Construction. All problems, questions, coordination, etc. related to electrical work shall take place through this person to the Architect.

1.5. PERMITS, FEES, AND INSPECTIONS

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

- B. Permits and fees shall comply with Division 01 Section, General Requirements.
- C. Notify Inspection Authorities to schedule inspections of work.
- D. Notify Architect and Engineer in advance of scheduled inspections.
- E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.
- F. State Mandated Electrical Inspections: The Contractor shall obtain electrical installation inspection from a non-governmental electrical inspector approved by the State Fire Marshal. The Contractor shall coordinate inspections, coordinate inspection schedule with the Owner, and obtain the electrical inspection certificate within 15 days after completion of electrical installation. The Contractor shall obtain electrical inspections of portions of the Work as they are completed and as required by the electrical inspector, and sufficiently ahead of close-in work so that corrections and re-inspections may be made, and in all cases while the area is accessible and visible for inspection.

1.6. UTILITY COMPANY COORDINATION

- A. The Owner/Engineer has made the initial service application to Delaware Electric Cooperative (DEC) for the purposes of obtaining a new electric service. The utility company's contact person is Troy Dickerson, P.E. 302-349-3125, tdickerson@delaware.coop. After notice to proceed, the Contractor is responsible for all communication, scheduling, site meetings, and follow-up with the utility company necessary for the installation of said utility in a timely manner, so service is active and available when needed for start-up, testing, and operation of all equipment and systems prior to substantial completion. Utility fees are to be paid directly by the Owner.
- B. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.
- C. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

1.7. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.
- B. Examine and verify specific conditions described in individual Specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.8. INTERPRETATION OF DOCUMENTS

- A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.
- B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with overhead ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.
- C. No electrical equipment, e.g. transformers, panelboards, disconnect switches, motor controllers, etc. shall be installed beneath ductwork, piping, etc.
- D. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.
- E. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.
- F. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.
- G. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- H. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, and Owner.
- I. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.
- J. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.9. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless

otherwise indicated or specified, and of the specified type and quality. Existing items of equipment are being relocated/reconnected under another Division of these Specifications. The Contractor shall be responsible for connecting all utilities as shown on the Drawings, to equipment identified as existing.

- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.10. ELECTRICAL WORK UNDER OTHER DIVISIONS

- A. Architectural Equipment and Systems
 - 1. In general, any electrically operated or controlled equipment furnished under Architectural divisions shall be supplied with control wiring, transformers, contacts, etc.
 - 2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.
 - 3. Architectural Equipment refers to, but is not limited to the following:
 - a. Cabinets, Casework and Countertops
 - i. Do not install outlets, switches, etc. behind casework, cabinets, etc.
 - ii. Receptacle outlets and data/telephone outlets shall be mounted above the countertops unless otherwise indicated.
 - iii. Where outlets are installed below countertops, provide grommets through countertops for cabling. Coordinate drilling of casework/countertops with casework installer.
 - iv. Coordinate outlets above and below countertops with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.
 - b. Classroom and Garage Equipment
 - i. Includes, but is not limited to automotive lifts, tire changers, tire

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.
3. Certain mechanical units are furnished from the factory with motor starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, Division 26 shall coordinate with Division 23 such that only one set of starters, fuses, switches, etc. is provided.
4. Some HVAC equipment must be protected by fuses, which shall be marked on the equipment nameplate. In these instances, if the equipment has an integral non-fused disconnecting means, the fusible safety switch indicated on the electrical drawings must remain per NEC Article 440.
5. In general, control and interlock equipment (including, but not limited to wiring, conduit, transformers, relays, contacts, etc.) for HVAC equipment and systems is furnished under Division 23. Division 26 shall install and connect all equipment as necessary.
6. HVAC equipment refers to, but is not limited to the following:
 - a. Air Handling Units
 - b. ATC Panels
 - c. Boilers
 - i. Coordinate connection type (i.e. switch or cord-and-plug) with approved shop drawings.
 - ii. Coordinate emergency shut-down provisions (i.e. control circuit versus shunt-trip mechanism) with Division 22.
 - d. Branch Selector Boxes
 - e. Condensing Units
 - f. Ductless Split Systems
 - g. Ductwork
 - i. Do not install any electrical equipment, including but not limited to switchboards, transformers, panelboards, safety switches, motor controllers, etc. beneath ductwork. Where this cannot be accomplished due to field conditions, notify the Architect/Engineer in writing.
 - h. Energy Recovery Ventilators
 - i. Exhaust Fans
 - j. Heat Pumps
 - k. Radiant Heat Panels
 - l. Ventilation Fans
 - m. Relief Air Fan
7. To ensure proper electrical coordination between the electrical components supplied under Division 26 and the equipment supplied under Division 23, a schedule shall be submitted, prior to start of work, for review by the Engineer with the following column headings:
 - a. Equipment or Item
 - b. HP or KVA

- c. Voltage and Phase
- d. Power Factor
- e. Capacitor
- f. Motor Starter
- g. Disconnect
- h. Controls
- i. Remarks

D. Owner Furnished Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished by the Owner shall be supplied with control wiring, transformers, contacts, etc.
2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.
3. Owner equipment refers to, but is not limited to the following:
 - a. Existing Appliances and/or Equipment
 - b. Electronic Appliances
 - i. Includes, but is not limited to televisions, computers, copy/fax machines, printers, etc.
 - ii. Verify equipment nameplates and connection requirements prior to rough-in.
 - iii. Coordinate mounting heights and locations of outlet boxes serving appliances with approved appliance product data and approved casework shop drawings where applicable.

E. Plumbing Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under Plumbing divisions shall be supplied with control wiring, transformers, contacts, etc.
2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.
3. Certain plumbing units are furnished from the factory with motor starters, contactors, transformers, fuses, wiring, etc., required for pumps, etc. When this equipment is supplied from the factory, Division 26 shall coordinate with Division 22 such that only one set of starters, fuses, switches, etc. is provided.
4. In general, control and interlock equipment (including, but not limited to wiring, conduit, transformers, relays, contacts, etc.) for plumbing equipment and systems is furnished under Division 22. Division 26 shall install and connect all equipment as necessary.
5. Plumbing equipment refers to, but is not limited to the following:

- a. Electric Water Coolers
 - i. Coordinate mounting height and location of receptacle outlets serving electric water coolers with approved shop drawings.
- b. Floor Drains
 - i. Coordinate routing of conduits and raceways in floor slabs with floor drains.
- c. Flush Valves
 - i. Coordinate mounting height and location of outlet boxes serving electronic flush valves with approved shop drawings and Division 22.
- d. Gas-Fired Water Heaters
 - i. Coordinate connection type (i.e. switch or cord-and-plug) with approved shop drawings.
 - ii. Coordinate emergency shut-down provisions (i.e. control circuit versus shunt-trip mechanism) with Division 22.
- e. Piping
 - i. Do not install any electrical equipment, including but not limited to switchboards, transformers, panelboards, safety switches, motor controllers, etc. beneath piping. Where this cannot be accomplished due to field conditions, notify the Architect/Engineer in writing.
- f. Recirculation Pumps
- g. Sinks
 - i. Provide weather-resistant NEMA 5-20R receptacle outlet with GFCI protection for control power transformer serving automatic lavatory faucets. Coordinate mounting height and location of receptacle outlets with approved shop drawings.
- h. Trap Priming Stations

1.11. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.12. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:
 - 1. ADA - Americans with Disabilities Act
 - 2. ANSI - American National Standards Institute
 - 3. ASTM - American Society for Testing and Materials
 - 4. CSA - Canadian Standards Association
 - 5. DNREC - Delaware Department of Natural Resources and Environmental Control

- 6. EPA - Environmental Protection Agency
- 7. FM - Factory Mutual
- 8. IBC - International Building Code
- 9. IEEE - Institute of Electrical and Electronics Engineers
- 10. NEC - National Electrical Code
- 11. NECA - National Electrical Contractors Association
- 12. NEMA - National Electrical Manufacturers Association
- 13. NFPA - National Fire Protection Association
- 14. OSHA - Occupational Safety and Health Act
- 15. UL - Underwriters' Laboratories

- B. The application standards of Delaware Electric Co-op.
- C. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in Electrical Construction Materials List of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the Electrical Appliance and Utilization Equipment List of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.13. SUBMITTALS

- A. Product Data: Include complete descriptive product data for items specified in Part 2 of this Section.

1.14. SUBMITTAL PROCEDURES

- A. Refer to Division 01, Section "Submittal Procedures" for requirements in addition to those indicated herein.
- B. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect, and/or Engineer, to be in the best interest of the Owner.
- C. After acceptance of Material and Equipment List, submit three (3) copies, or more as required under the General Conditions, of complete descriptive data for all items as outlined below.
- D. Electronic submittals shall be prepared as a Portable Document Format (PDF) file and shall include as page 1 the Contractor's stamp, followed by the submittal contents. Submittal

form shall identify the Project, Contractor, Subcontractor or Supplier, and pertinent Contract Document references.

- E. Submittals shall consist of specifications, product data sheets, manufacturer's catalog cuts, dimensional shop drawings, wiring diagrams, installation instructions, samples, and any other information necessary to indicate complete compliance with Contract Documents.
- F. Submittals shall include, but not be limited to, the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Document requirements.
- G. Identify submittals, indicating intended application, location and service of submitted items. Refer to Specification sections or paragraphs and Drawings where applicable.
- H. Clearly indicate exact type, model number, style, size, operating characteristics, ratings, options and special features of proposed item specifically for application to this project. Submittals of a general nature will not be acceptable.
- I. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- J. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and all electrical requirements for equipment submitted. The Contractor shall be responsible for correctness of all submittals.
- K. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.
- L. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- M. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the Specification requirements if differences have not been clearly indicated in the submittal.
- N. Where proposals to use an item of equipment or application other than that specified or detailed on the Contract Drawings, which requires any redesign of the structure, partitions, foundation, HVAC, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required thereafter shall be prepared by the Contractor at his own expense for review by the Owner's representative before any such work is implemented.
- O. All Contractor-proposed changes and revisions shall be at the Contractor's risk and expense. The Contractor shall fully coordinate all revisions, substitutions and changes with other trades for a complete, code compliant, and fully functional installation.

- P. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- Q. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct submittal. Identify all submittals by the name of the item/system and the applicable Specification Section and/or Drawing number. Grouping of items/systems that are not related shall be unacceptable.
- R. Items and Systems
1. Access Doors
 2. Analysis & Coordination Study
 3. Arc Flash Hazard Analysis
 4. Arc Flash Hazard Labels
 5. Drivers for Lighting Fixtures
 6. Circuit Breakers
 7. Conductors and Cables - 600V or Less
 8. Conduit and Raceway
 9. Connectors and Splices
 10. Disconnect (Safety) Switches
 11. Electrical Connection Coordination Schedule
 12. Emergency Off Push-Buttons
 13. Enclosed Circuit Breakers
 14. Equipment Nameplates/Labels
 15. Firestopping Materials
 16. Foam Duct Sealant
 17. Fuses, 600V or Less
 18. Ground Busbars
 19. Ground Conductors
 20. Ground Rods
 21. Grout

22. Handholes
23. Hangers and Supports
24. Identification Products
25. Installation/Coordination Drawings
26. Installer Certificates
27. Junction and Pull Boxes, Standard Sizes
28. Lamps
29. Lighting Control System
30. Lighting Fixtures, Exterior
31. Lighting Fixtures, Interior
32. Motor Controllers
33. Operation and Maintenance Manual
34. Outlet and Device Boxes
35. Panelboard Circuit Directories
36. Panelboards
37. Qualification Data
38. Receptacles
39. Record Drawings
40. Retractable Cord Reels
41. Sleeves
42. Surge Protective Devices
43. Testing Agency Qualifications
44. Test Reports
45. Toggle/Snap Switches
46. Transformers, 600V and Less
47. Underground Ductbank Products

- 48. Weatherproof Boxes and Covers
- 49. Wiring Diagrams
- S. Submit for approval any other submittals as required by the Architect, Engineer, or Owner. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- T. Prepare and submit a detailed schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.
- U. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.15. SHOP DRAWINGS

- A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.
- B. Shop drawings shall include identification of products being installed, compliance with specified standards, notation of coordination requirements, notation of dimensions verified by field measurement, etc. Do not base shop drawings on reproductions of the Contract Documents or standard printed data.
- C. Submit shop drawings concurrent with product data. Shop drawings received without associated product data will be returned without review.
- D. Submit for approval schematic diagrams of each electrical system installed in the building, including but not limited to Riser Diagrams and Schematic Wiring Diagrams for the following systems:
 - 1. Grounding and Bonding System
 - 2. Lighting Control System
 - 3. Occupancy Sensor Layout
- E. Shop Drawing diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be inserted into the O&M Manual specified herein.
- F. Submit for approval any other shop drawings as required by the Architect, Engineer, or Owner. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's

funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

- H. Refer to individual Specification Sections and Contract Drawings for additional shop drawing requirements.
- I. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.16. DEFINITIONS

- A. Approve: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. Building Line: Exterior wall of building.
- C. Concealed: Hidden from sight in chases, formed spaces, shafts, hung ceilings, or embedded in construction.
- D. Conduits: Include conduit, all fittings, identification, and other accessories relative to such conduit.
- E. Contractor: The Electrical Contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- F. EPDM: Ethylene-propylene-diene terpolymer rubber
- G. Exposed: Not installed underground or concealed as defined above.
- H. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. Furnish and install or Provide: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- J. Location, Damp: Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc...
- K. Location, Dry: A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.
- L. Location, Wet: Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc...) commercial kitchens, and vehicle washing areas.
- M. NBR: Acrylonitrile-butadiene rubber.
- N. Review: Limited observation or checking to ascertain general conformance with design

concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.17. RECORD DRAWINGS

- A. Upon completion of the electrical installations, the Contractor shall deliver to the Architect one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering the same to the Architect.

1.18. WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the General Conditions.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The Contractor guarantees for a two (2) year period from the time of final acceptance by the Owner:
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
 - 3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
 - 4. That the entire work shall be water-tight and leak-proof.

1.19. OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared three (3) hardcopies and one (1) electronic copy of the Operation and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.
- B. The manual shall be bound in a three ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front and spine of the binder: Operation and Maintenance Manual – DTCC Owens Campus Automotive Center - Electrical. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out.

- C. Provide divider tabs and table of contents for organizing and separating information. Tab titling shall be clearly printed under reinforced plastic tabs.
 - 1. If more than one (1) binder is required, volume numbers shall be included on front and spine of each volume.
 - D. Provide the following data in the manual:
 - 1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 - 2. Directory listing names, addresses, e-mail addresses, and telephone numbers for Architect, Engineer, Construction Manager, Contractor, Sub-contractor(s), equipment suppliers, sales and authorized service representatives.
 - 3. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 - 4. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's Comments (if any).
 - 5. Manufacturer's extended limited warranties on equipment.
 - 6. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing(s).
 - 7. Access panel charts with index illustrating the location and purpose of access panels.
 - 8. Approved Electrical Certificates, including certificate of approval from electrical inspector.
 - 9. List of extra materials turned over to Owner, with transmittal/receipt signed by Owner.
 - 10. Sign-in sheets from demonstration and training sessions.
 - 11. Start-up and test reports for equipment.
 - E. Additional items identified within other Sections of these Specifications.
 - F. Submit Operation and Maintenance Manual prior to the anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operation and Maintenance Manuals be reviewed and approved.
- 1.20. INSTRUCTION
- A. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.
 - B. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

- C. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.
- D. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one (1) 8-hour day.
- E. Where specified in technical sections, provide longer periods required for specialized equipment.
- F. The Operation and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.
- G. Deliver all instruction materials to the Owner prior to the formal instruction period.
- H. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.
- I. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.21. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record demonstration and training video recordings as indicated in subsequent specification sections. 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.

1.22. INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:
 - 1. Mechanical Rooms indicating transformers, panelboards, enclosures, boxes, conduits, mechanical equipment, ductwork, and piping, etc...
 - 2. Electrical Rooms indicating panelboards, enclosures, boxes, transformers, conduits, wireways, etc...
- B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams. Where field connections are shown

to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.

- D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout Drawings shall include, but not be limited to the following:
1. Pad-mounted equipment and equipment connections.
 2. Underground conduits and ductbanks.
 3. Building penetrations.
- E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:
 - a. Working space and dedicated space clearances per the NEC.
 - b. Clearances for equipment disassembly required for periodic maintenance.
 - c. Exterior wall and foundation penetrations.
 - d. Fire-rated wall and floor penetrations.
 - e. Equipment connections and support details.
 - f. Sizes and locations of required concrete bases.
 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.
 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.
 5. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful bidder shall familiarize himself with all other related documents to avoid possible demolition and installation conflicts.

PART 2. PRODUCTS

2.1. SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, 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 (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
- b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2. GROUT

A. Nonmetallic, Non-Shrink Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3. FOAM DUCT SEALANT

A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Polywater Corporation

C. Basis of Design: FST Foam Sealant by American Polywater Corporation.

D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.

E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a ten sile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).

F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.

G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight

H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.

I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.

J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.4. BACKBOARDS

- A. Backboards: Plywood, A/C grade, fire-retardant treated, 3/4" x 48" x 96" (19 x 1220 x 2440 mm) with no added urea formaldehyde.
- B. Install each fire-retardant-treated plywood backboard six inches off the floor to bottom. Secure backboards with a minimum of eight (8) screws. Plywood backboards shall have one side with exterior glue and one finished smooth side. Mark all backboards and cabinets with appropriate legends (e.g., "COMM").
- C. Verify with local codes or AHJ prior to painting fire-retardant-treated plywood backboard with stamped fire rating labels. If allowed by code, paint fire-retardant-treated plywood backboard with coats of durable white enamel (or other finish color as selected by the Architect).

2.5. FASTENERS

- A. All fasteners located in public spaces including classrooms, corridors, lobbies, toilet rooms, etc..., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

2.6. PROTECTIVE WIRE GUARDS/SHIELDS

- A. Provide protective guards over devices subject to physical damage. All devices installed in mechanical and electrical rooms shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800-328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).
- B. Devices to be provided with protective guards include, but are not limited to, the following:
 - 1. Lighting Fixtures
 - 2. Fire Alarm Pull Stations
 - 3. Thermostats
 - 4. Smoke/Heat Detectors
 - 5. Speakers
 - 6. Fire Alarm Audio/Visual Devices (Horns, Strobes, etc...)
 - 7. Exit Signs
 - 8. Emergency Lighting Units
 - 9. Security Devices/Motion Detectors
 - 10. Wiring Devices

11. Emergency Shut-Off Stations
 12. Other Devices as required by Owner
- C. Wireguards shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Wireguards shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall be red finish color.
 - D. Indoor Protective Shield: Factory-fabricated, clear thermoplastic 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.
 - E. Protective guards/shields shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

PART 3. EXECUTION

3.1. TEMPORARY FACILITIES:

- A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.
- B. Description: Furnish and install the necessary metering and distribution equipment for an adequate, 3-phase, 4-wire temporary electrical service and all temporary wiring, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service shall be determined by the successful bidder.
- C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.
- D. Materials:
 1. Lights at each floor in each stair. At least one light outlet per 900 square feet on each floor.
 2. One 20-ampere circuit with ground fault protection for each 7500 square feet of gross floor area per floor to which various trades may attach their cords.
 3. One temporary power line in corridor including connections to saws, if required, with ground fault protection.
 4. Power for crane operation if required.
- E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	5
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	10

- F. The Owner shall pay for all energy charges for temporary service.
- G. Obtain and pay for temporary electrical service for construction power.
- H. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from utility company lines..
- I. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

3.2. COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. 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.
- D. Install equipment with working space and dedicated space in strict accordance with NEC Article 110.
- E. 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.
- F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- G. Verify exact electrical requirements for each piece of equipment receiving one or more electrical connections, including but not limited to voltage, phase, and maximum fuse/overcurrent protection device rating. Provide electrical circuit of proper characteristics to serve provided equipment.
- H. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.
- I. Make all connections to equipment in accordance with manufacturer's instructions.

- J. Right of Way: Give to piping systems installed at a required slope.
- K. Coordinate electrical work under other Divisions in accordance with Part 1 of this Section, Article "Electrical Work Under Other Divisions".

3.3. 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. Sleeves installed in floors shall extend 2 inches (50 mm) above finished floor level unless otherwise indicated on the Contract Drawings.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) 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
- I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. 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.
- K. 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 of Division 26 Section "Electrical Firestopping".
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and joint sealant/grout.

3.4. 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 26 Section, "Electrical Firestopping".

3.5. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.
- C. Installing Equipment Foundations (Housekeeping Pads):
 - 1. Provide four (4) inch high concrete foundations (housekeeping pads) for all interior pad-mounted equipment, extending a minimum of 6 inches beyond equipment bases, unless otherwise noted.
 - 2. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and finish exposed surfaces smooth.
 - 3. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.
 - 4. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.
 - 5. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.
- D. Refer to Division 26 Section "Hangers and Supports" for additional requirements.

3.6. PROVISIONS FOR ACCESS

- A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.
- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.
 - 1. Acoustical or Cement Plaster: Style B
 - 2. Hard Finish Plaster: Style K or L

3. Masonry or Dry Wall: Style M

- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of Specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.
- F. Provide sufficient access and working space for repair and maintenance about all lighting and electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.7. PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.
- F. Remove all construction marking and writing from exposed equipment, conduit, boxes, and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by the Architect, unless otherwise indicated by the Owner.
- H. All exposed conduit, boxes, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.8. COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.

3.9. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.10. OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
- C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.
- D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section "Temporary Facilities and Controls".
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.11. TESTING AND ADJUSTMENT

- A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.
- B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.
- C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.
- D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.
- E. Submit all test results to the Architect for approval.

3.12. WALL AND FLOOR PENETRATIONS

- A. All penetrations of partitions, ceilings, roofs and floors under Division 26 shall be sleeved, sealed, and caulked as specified herein.
- B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, "Electrical Firestopping".
- C. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations. Escutcheons shall match those provided under Division 23.
- D. Conduit sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.

3.13. EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.14. OUTAGES

- A. Provide a minimum of seven (7) days' notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.
- B. Submit Outage Request Form, attached at the end of this Section, to Owner for approval.

3.15. CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

3.16. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking

to make penetrations absolutely watertight.

- B. Where conduits penetrate roofs, flash pipe with Stoneman Stormtite, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.
- C. Furnish and install pitch pockets or weather tight curb assemblies where required.
- D. Furnish and install curbs and sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these Specifications.

3.17. CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.
- B. Concrete shall achieve compressive strength not less than 3,000 psi after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.
- D. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:
 - 1. Slabs - 3/4 inch
 - 2. Concrete poured against earth - 3 inches
 - 3. Other locations - 2 inches
- E. Properly align, level, and grout all equipment where necessary.

3.18. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.
- B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.
- C. Where the work specified under Division 26, or under other Divisions, requires relocation

of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition.

- D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

3.19. COORDINATION

- A. 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.
 - 5. To provide working space and dedicated space clearances per NEC Article 110.26.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. 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 this Section.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Electrical Firestopping".

3.20. DEMOLITION

- A. Unless otherwise noted all existing equipment, conduit, wire, etc., shall remain.
- B. Where existing equipment is indicated to be removed, all associated conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc..., shall also be removed. Patch, paint and repair walls/roof/floor to match existing and/or new finishes.
- C. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.
- D. The location of all existing equipment, conduits etc., indicated is approximate only and shall be checked and verified. Provide all new electrical work required to connect to or clear existing work as applicable.
- E. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authority(ies) Having Jurisdiction (AHJ).

- F. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing conduit systems to new conduit systems.
- G. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.
- H. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- I. Deliver to the Owner, on the premises where directed, existing equipment and materials which are removed and which are desired by the Owner or are indicated to remain the property of the Owner.
- J. All other materials and equipment which are removed shall become property of the Contractor and shall be promptly removed, from the premises, and disposed of by the Contractor, in an approved manner. Contractor shall be responsible for proper disposal of all removed equipment containing PCB's.
- K. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetration voids with like materials and paint to match existing construction.
- L. Where required, provide and coordinate removal and re-installation of existing equipment. Take care to protect materials and equipment indicated for reuse. Contractor shall repair or replace items which are damaged. Contractor shall have Owner's representative present to confirm condition of equipment prior to demolition.
- M. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.
- N. All devices and equipment designated by the Owner to remain the property of the Owner shall be moved and stored by the Contractor at a location on site as designated by the Owner. It shall be the Contractor's responsibility to store all devices and equipment in a safe manner to prevent damage while stored.
- O. All existing equipment refused by the Owner shall become the property of the Contractor and shall be removed from the site by the Contractor in a timely manner and disposed of in a legal manner.
- P. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- Q. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.21. EXCAVATION AND BACKFILLING

- A. General:
 - 1. Perform all necessary excavation, or installation of work under Division 26, in

whatever materials or conditions encountered, using suitable methods and equipment.

2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation:

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and other applicable Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling:

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION

OUTAGE REQUEST FORM

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE - TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____

(FOREMAN OR OTHER PERSON IN CHARGE)

PART 1 (FOR OWNER'S USE ONLY):

APPROVED: _____

YES ___ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ___ NO: ___ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

SECTION 260519 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 building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3. SUBMITTALS

- A. Product Data: Provide for each cable assembly type, wire, cables, conductors, and connectors.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Indicate procedures and values obtained.
- C. Project Record Documents: Record actual locations of components and circuits.

1.4. QUALITY ASSURANCE

- A. Testing Agency Qualifications: In addition to requirements specified in Division 01 Section, "Quality Control", an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full member company of the International Electrical Testing Association.
 - 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 of this Section.
- B. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.
- C. Comply with NEMA/Insulated Cable Engineers Association (ICEA) Standards.
- D. Comply with NECA Standard of Installation.
- E. Comply with NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- F. American Society for Testing and Materials (ASTM): Comply with requirements of the

following:

1. B3: Standard Specification for Soft or Annealed Copper Wire
 2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 3. D753: Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable
 4. B800 Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes.
 5. B801 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation.
 6. B836 Standard Specification for Compact Round Stranded Aluminum Conductors Using Single Input Wire Construction.
- G. Electrical Testing Laboratories (ETL): Provide wiring, cabling and connector products which are ETL listed and labeled.
- H. Institute of Electrical and Electronics Engineers (IEEE): Comply with the following standards which apply to wiring systems:
1. 82: Test procedure for Impulse Voltage Tests on Insulated Conductors
 2. 241: Recommended Practice for Electric Power Systems in Commercial Buildings
- I. NFPA: Comply with NFPA 70 requirements for construction, installation and color coding of electrical wire, cable and connections.
- J. National Electrical Manufacturer's Association (NEMA): Comply with requirements of the following:
1. WC70: Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- K. UL: Provide material conforming to the following standards:
1. UL 83 - Thermoplastic-Insulated Wires and Cables.
 2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
 3. UL 854 - Service-Entrance Cables
- L. UL Labels: Provide wiring, cabling and connector products which are UL listed and

labeled.

1.5. DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26, Binational Wire and Cable Packaging Standard.
- B. Storage: Store wire and cable in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handling: Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

1.6. COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer and Architect.
- C. Determine required separation between cables and other work.
- D. Determine cable routing to avoid interference with other work.

1.7. PROJECT CONDITIONS

- A. Verify that field measurements are as shown on the Drawings.
- B. Feeder conductor sizes are based on copper as indicated on the "Feeder Schedule" on the Contract Drawings.
- C. Branch circuit conductor sizes are based on copper.
- D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- E. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- 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. Wires and Cables:
 - a. American Insulated Wire Corp.
 - b. BICC Brand Rex Company.

- c. General Cable.
- d. Senator Wire & Cable Company.
- e. Southwire Company.
- f. Colonial Wire Company.

2. Connectors and Accessories for Wires and Cables:

- a. 3M Company; Electrical Products Division.
- b. AMP Incorporated.
- c. Buchanan.
- d. General Signal; O Z/Gedney Unit.
- e. Greaves Corporation.
- f. Ideal Industries.
- g. Monogram Company; AFC.
- h. NSI Industries, Inc.
- i. Square D Company; Anderson.

3. Metal Clad (MC) Cable

- a. Alcan Cable.
- b. Atkore AFC Cable Systems.
- c. Encore Wire Corporation.
- d. General Cable.
- e. Nexans.
- f. Pysmian Cables and Systems.
- g. Service Wire Company.
- h. Southwire Company.
- i. United Copper Industries.

4. Metal Clad (MC) Connectors

- a. Arlington Industries, Inc.
- b. Bridgeport.
- c. Crouse-Hinds.
- d. Thomas & Betts.

2.2. BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction and rating as specified herein.
- B. Building wires and cables shall be annealed (soft) copper, 600 volt, Type THHN/THWN (dual-rated) single conductors rated 90°C dry / 75°C wet, with a minimum conductivity of 98 percent at 20°C (68°F), or a maximum resistivity of 1.7 micro-ohms per centimeter.
- C. Conductors shall meet or exceed requirements of all applicable ASTM specifications, UL Standard 83, UL Standard 1581, NEMA WC 70, Federal Specification A-A-59544 and

shall be RoHS/REACH Compliant.

- D. Conductors shall be solid for 10 AWG and smaller, and stranded for 8 AWG and larger.
- E. Building wire and cables shall be color-coded using colors factory impregnated throughout the insulation and jacket. The following color code convention(s) shall be used:
 - 1. 120/208-Volt, 3-Phase, 4-Wire System:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
 - 2. 277/480-Volt, 3-Phase, 4-Wire System:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 - d. Neutral: Gray
 - e. Ground: Green
 - 3. 120/240-Volt, 1-Phase, 3-Wire System:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Neutral: White
 - d. Ground: Green

2.3. CONNECTORS AND SPLICES

- A. UL listed, factory fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 Article, "Wire and Insulation Applications".
- B. Split Bolt Connectors: Not acceptable.
- C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- D. Spring Wire Connectors: Not acceptable.
- E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.
- G. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90 degrees C and shall be material flame-retarded per IEEE 383 Vertical

Tray Flame Test.

- H. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.
- I. Wire Nut Connectors:
1. Description: Twist-on wire connectors for branch circuit conductors 10 AWG and smaller with a color-coded housing.
 2. Construction: Flame-retardant polypropylene housing, rated for 105 degrees Celsius. Zinc-plated steel insert. Square-wire spring to maintain secure positive grip that will not relax over time, no pre-twisting required.
 3. Dimensions: Connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volts minimum).
 4. Quality Assurance:
 - a. UL Listed to 486C and 94V-2 Flame Rating.
 - b. CSA Certified to C22.2 No. 188
 - c. RoHS Compliant
 5. Special Features:
 - a. Wire connectors for making grounding connections shall have green-colored housing and shall have opening at end of connector for grounding conductor to pass through for connection to metallic outlet boxes.
 - b. Wire connectors for all exterior and underground work and work in damp/wet interior locations shall be pre-filled with silicone-based sealant to protect against moisture and corrosion, and shall be UL Listed to 486D for use in damp/wet locations, including direct burial applications.
 - c. Wire connectors for high temperature applications, e.g. high-wattage lighting fixtures and signs, shall be UL listed to 150 degrees Celsius, and shall have a black fire-retardant plastic shell design to withstand heat build-up.
 6. Basis of Design: Provide products by Ideal Industries, Inc. or approved equal.
- J. Gel Tap Splices (for Conductors 10 AWG and Smaller in Damp/Wet Locations)
1. Description: Gel sealant filled splice for buried, underground, and overhead applications for low voltage (1000V or less) circuits. Protects connections from moisture ingress, corrosion, and pollution.
 2. Construction: Range-taking mechanical connector made of aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant

polypropylene provides rugged protection. Silicone gel is hydrophobic dielectric insulation and provides constant pressure on cable and connector to provide water seal. Seal is specially formulated for high temperature environments.

3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating.
4. Quality Assurance: UL listed.
5. Special Features: Silicone gel shall easily peel away from connector, leaving a clean connection. Splices shall be rated for temperatures from -40 degrees Celsius to 90 degrees Celsius.
6. Basis of Design: GTAP Series as manufactured by Raychem/Tyco, or approved equal.

K. Insulated Connectors (for Conductors 8 AWG and Larger in Dry Locations)

1. Description: Multi-conductor connectors for low voltage (600V or less) circuits, insulated with high-dielectric strength plastisol, molded for precise fit and supplied with removable access plugs over the hex screws.
2. Construction: Range-taking mechanical connector made of aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant polypropylene provides rugged protection. Mounting holes at each end of the connector for direct isolated mounting to wiring trough, panelboard, or wireway.
3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes, quantities, and voltage rating.
4. Quality Assurance: UL listed. UV resistant.
5. Special Features: Connectors shall be rated for temperatures from -45 degrees Celsius to 90 degrees Celsius.
6. Basis of Design: IPLM/IPLMD Series as manufactured by Polaris, or approved equal.

L. Gel Filled Insulated Connectors (for Conductors 8 AWG and Larger in Damp/Wet Locations)

1. Description: Multi-conductor connectors for low voltage (1,000V or less) circuits, insulated with high-dielectric strength plastisol, molded for precise fit and supplied with removable access plugs over the hex screws. Gel-filled for damp/wet or submersed locations to protect connections from moisture ingress and corrosion.
2. Construction: Range-taking mechanical connector made of tin-plated aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant polypropylene provides rugged protection. Cable entry ports and

hinged screw port caps shall be sealed with hydrophobic dielectric gel insulation.

3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes, quantities, and voltage rating.
4. Quality Assurance: ANSI C119.1 for complete unit, ANSI C119.4 for connector, ASTM D543 for chemical resistance, ASTM G-53-95 and ASTM D-638-95 for UV resistance.
5. Special Features: Silicone gel shall be easily removed from conductor for re-entry. Connectors shall be rated for temperatures from -40 degrees Celsius to 95 degrees Celsius.
6. Basis of Design: GPRT Series as manufactured by Raychem/Tyco, or approved equal.

2.4. METAL CLAD (MC) CABLE

- A. Cable shall meet or exceed the requirements of UL Standard 83, UL Standard 1063, and UL Standard 1569 for Type MC cable, Federal Specification A-A59544 Vertical Cable Tray Flame Test and the National Electrical Code. Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
- B. Cable shall be constructed with soft drawn copper, 600 volt, type THHN/THWN conductors rated 90°C dry/75°C wet, with a green insulated grounding conductor. Conductors shall be cabled together with a binder tape bearing a print legend that is wrapped around the assembly. An aluminum interlocked armor shall be applied over the assembly. Conductors shall be protected by an anti-short bushing at each termination.
- C. Cable serving lighting fixtures and/or lighting control devices with 0-10V dimming controls shall have 16 AWG copper TFN insulated single conductors within interlocked armor. Control conductors shall have purple and gray insulation/jacketing.
- D. Only cables with conductor sizes 12 AWG and 10 AWG shall be permitted.
- E. Multi-circuit MC cable is not permitted.

2.5. METAL CLAD (MC) CABLE CONNECTORS

- A. Snap-In Connectors
 1. Snap-in connectors for metal clad cable shall be constructed of die-cast zinc, shall be compatible with steel and aluminum cables, and shall have the following features:
 - a. Insulated throat
 - b. Removable ring to secure connector to box
 - c. Angled, two-prong clip to secure cable
 - d. Removable screw to secure cable clip

2. Snap-in connectors shall be available in a variety of sizes and configurations to accommodate different cable sizes/diameters, wire counts, cable counts, etc.
 3. Single connectors shall be compatible with 1/2-inch knockouts. Duplex connectors shall be compatible with 3/4-inch knockouts.
 4. Provide SNAP²IT connectors as manufactured by Arlington Industries, Inc., or approved equal by listed manufacturer.
- B. Lock-Nut Connectors
1. Straight connectors shall be one-piece spring-steel, set screw design with nylon insulator and locknut. Provide ACB series, as manufactured by Crouse-Hinds, or approved equal.
 2. 45 and 90 degree connectors shall be die cast zinc, clamp type with insulated throat and locknut. Provide ACBXX45 or ACBXX90 series as manufactured by Crouse-Hinds, or approved equal.

2.6. INSULATING TAPE, PUTTY, RESIN AND SUPPORTS

- A. Tape: Provide plastic electrical insulating tape which is flame-retardant, cold and weather-resistant. Tape for use in areas subject to temperatures 30 degrees C to 105 degrees C, or where the tape will be subjected to an oil splash, tape shall have a minimum thickness of 8.5 mils, and shall consist of an oil-resistant acrylic adhesive.
- B. Materials: Provide all insulating materials for splices and connections such as glass and synthetic tapes, putties, resins, splice cases, or compositions of the type approved for the particular use, location, voltage and temperature and apply and install in an approved manner, all in accordance with the manufacturer's recommendations.
- C. Supports: Provide cable supports of the wedge type which firmly clamp each individual cable and tighten due to the cable weight.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. By beginning work, the Contractor has accepted conditions and assumes responsibility for

correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2. PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3. WIRE AND INSULATION APPLICATIONS

- A. No branch circuit wires smaller than 12 AWG shall be used unless otherwise indicated. Conductors shall be continuous from outlet to outlet and from terminal board to point of final connection, and no splice shall be made except within outlet or junction boxes. All conductors shall be of the size indicated. All wires 8 AWG and larger shall be stranded.
- B. Control wiring shall not be less than 14 AWG and shall be color coded using colors impregnated into the insulation. All control wiring shall be color coded with wires of colors different from those used to designate phase wires.
- C. All wiring, contacts, and terminal blocks shall be suitably tagged for ease in identification and tracing of circuits. Identification tags shall be engraved fiber or plastic type, subject to acceptance. Wires shall be numbered and coded, using Brady Quicklabels, or equal.
- D. Wiring shall be tagged at terminations, in pull boxes, junction boxes, outlet boxes, panelboards, etc...
- E. Switch leg wire shall be labeled with "S" tag.
- F. Wiring for general 15 and 20 amp branch circuit work shall be as follows unless otherwise indicated:

HOME RUN LENGTH AND WIRE SIZE				CIRCUIT LENGTH AND WIRE SIZE			
120 Volt		277 Volt		120 Volt		277 Volt	
0 – 60'	12AWG	0 – 175'	12AWG	0-100'	12AWG	0 – 200'	12AWG
60 – 100'	10AWG	175 - 350'	10AWG	100' & Up	10AWG	200' & Up	10AWG
100' & Up	8AWG	350> & Up	8AWG				

- G. Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.
- H. Joints of 10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or

equivalent shall be used.

- I. Joints of 8 AWG and larger shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy Hy dent, T&B Sta Kon, or equivalent. Connectors for control wiring shall be Burndy Hy Lug, or equivalent.
- J. All circuits for underground exterior electric work shall be 10 AWG (minimum) and contain a 10 AWG (minimum) copper grounding conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted on the Drawings.

3.4. MC CABLE APPLICATIONS

- A. MC cable shall be permitted only where concealed above accessible ceilings and/or within drywall partitions and in accordance with the requirements of Division 26 Section "Raceways and Boxes".
- B. MC Cable shall be allowed for connections within a room from a junction box to lighting fixtures.
- C. Conduit home runs shall be in electrical metallic tubing (EMT).
- D. MC cable shall be allowed from a junction box within a room to receptacles in the same room.
- E. MC cable shall not be allowed to cross one room to another room whether the wall between two rooms goes up to slab or not. If the rooms are identified as two separate rooms, MC cable shall not be used between the two rooms.
- F. MC cable shall not be used between two receptacles when they are in two separate rooms, on the same wall.
- G. Provide anti-short bushings for all MC cable terminations.
- H. Cables shall be supported with appropriate hangers; tie wire is not acceptable.
- I. MC cable shall not be used to support other cables/wires.
- J. Provide steel plates, minimum 1/16-inch thick, at all MC cable penetrations through bored holes in joists, rafters, and wood studs.

3.5. INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's Standard of Installation.
- B. Pull Conductors: Use a UL-listed and 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.
- C. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway. Completely and thoroughly swab conduit system

before installing conductors.

- D. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section, "Common Work Results for Electrical" and Division 26 Section, "Hangers and Supports".
- F. Seal around cables penetrating fire rated elements according to Division 26 Section, "Electrical Firestopping".
- G. Identify wires and cables according to Division 26 Section, "Electrical Identification".
- H. Conductors installed in parallel shall be of equal lengths.
- I. Wiring at Outlets: Install with at least 6 inches (150 mm) of slack conductor at each outlet in accordance with Article 300.14 of the National Electrical Code.
- J. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
- K. The Contractor shall provide suitable installation equipment to prevent cutting and abrasion of conductor insulation. The Contractor shall use suitable cable guides, pulleys, and protective sleeving to prevent damage to cable during installation. Ropes used for pulling of wire and cable shall be made of polyethylene or other suitable non-metallic material. Pulling lines shall be attached to cable by means of either woven basket grips or pulling types attached directly to the conductors. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the various insulations and raceway materials. The lubricants shall be certified by the manufacturer to be non-injurious to such insulation and materials.
- L. Each cable shall be labeled at terminals and at all accessible points in equipment and in pull boxes. Each wire shall be labeled at both ends. Labels shall be self-sticking wire markers.
- M. For rubber and plastic-covered wire and cable, pulling compound Ideal Yellow 77 may be used.
- N. Terminal lugs for wires 8 AWG and larger shall be T&B 54,000 Series or Burndy HY-Dent, compression type, unless noted otherwise. One-hole lugs for wires 4/0 AWG and smaller. Two-hole lugs for all wires 250 kcmil AWG and larger.
- O. Install wires and cables using braided rope larger than the cable being pulled to keep twists to a minimum.
- P. Provide an insulated green equipment grounding conductor (EGC), sized per NEC, for all

feeder and branch circuits, shown or not shown.

- Q. Multi-wire branch circuits shall not be permitted. Provide a separate insulated neutral (grounded) conductor for all feeder and branch circuits requiring a neutral connection.
- R. Where conductors are shown on the plans to be direct-buried, they shall be 2, 3, or 4 conductors each, with separate self-contained ground conductor, cable type UF or USE.
- S. Install electrical cables, wires, and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- T. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- U. Conductors installed in runs within 6 inches of heating pipes or equipment shall be of types required by the NEC and shall be listed for the application.
- V. No conductors shall be drawn into conduit until all work, which may cause cable damage, is completed.
- W. All wiring in lighting fixture channels, over boilers and breechings, and in other high ambient temperature areas, shall be of types required by NEC and shall be listed for the application.
- X. During installation, do not deform cable by improper bending, stretching, twisting, kinking, or pinching, nor do any other abusive handling. Any failure to observe these instructions will be detected and corrected during the demonstrations following completion of the installation.
- Y. All cable runs shall contain S loops or other means to accommodate expansion or contraction as required.
- Z. Cable bends will have a radius not less than the value recommended by the cable manufacturer.
- AA. Cables connected to electronic equipment in the system shall be tagged to show its function and the location of its other end.
- BB. All labels shall be of durable material and securely fastened to the cable.
- CC. Wiring of different system voltages shall not be mixed at pull boxes enclosures, surface metal raceway, wiretrough, etc., unless a barrier (separator) is provided between the differing systems.

3.6. CONNECTIONS

- A. Conductor Splices: Keep to minimum.
- B. Install splices and taps that possess equivalent or better mechanical strength and insulation

ratings than conductors being spliced.

- C. Use splice and tap connectors compatible with conductor material.
- D. Apply oxide inhibitor in each termination for aluminum conductors per manufacturer's instructions.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- F. 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.
- G. Wire splices and taps shall be adequate to carry full current rating of wire.
- H. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized where required. Wire connectors of insulating material or solderless pressure connections, properly taped, shall be utilized for all splices in wiring.
- I. Splices in branch circuits and feeders shall be made where indicated or as required for the installation. All splices shall be accessible and made in enclosure approved for that purpose.
- J. For splices in branch circuits provide connectors as follows;
 - 1. Wire Sizes 10 AWG and smaller: Provide wire nut connectors as specified in Part 2 of this Section.
 - 2. Wire Sizes 8 AWG and Larger: Provide insulated connectors as specified in Part 2 of this Section.
- K. Thoroughly clean wiring prior to installing lugs or connectors.

3.7. IDENTIFICATION

- A. All building wire and cable shall be color-coded to identify the electrical system(s) as specified. Where color-coding is field-applied, the same shall be accomplished with colored electrical tape wrapped concentrically around each conductor in half-lapped turns, for at least the last six (6) inches of the conductor. One turn around the conductor is not acceptable.
- B. Identify wire and cable using Thomas and Betts Type WM vinyl markers.
- C. Identify each phase and neutral conductor with its circuit number or other designation indicated on the Drawings in all junction, pull, terminal boxes, and cabinets.
- D. Provide identification tags on each conductor entering each panelboard, switch, junction

box, and pull box to identify conductor.

- E. Comply with the requirements of Division 26 Section, Electrical Identification.
- F. Feeder Identification: Securely fasten nonferrous identifying tags or pressure-sensitive labels to all cables, feeders, and power circuits in pull boxes, handholes, panelboards, and at termination of cables.
 - 1. Tags or labels shall be stamped or printed to correspond with markings on Contract Drawings or marked so that feeder or cable may be readily identified.
 - 2. [If suspended type tags are provided, they shall be attached by approximately 55-pound test monofilament line or slip-free plastic cable lacing units.]

3.8. FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection:
 - 1. Inspect for defects and physical damage, labeling, and compliance with requirements of drawings and schedules.
 - 2. Clean conductors using Manufacturer's approved methods and materials.
 - 3. Verify that conductors are correct size and are terminated with appropriately sized lugs.
 - 4. Verify that conductors are correct color for phase identification.
 - 5. Verify that conductors are labeled to identify circuit designation.
 - 6. Verify that neutral conductors are only terminated at neutral lugs/bus, and that grounding conductors are only terminated at grounding lugs/bus.
 - 7. Verify that oxide inhibitor is provided at all terminations for aluminum conductors.
- B. Electrical Tests: Upon installation of conductors and before electrical circuitry has been energized, provide the following minimum inspections and tests according to manufacturer's written instructions to ensure conductors are operational within industry and manufacturer's tolerances, are installed according to the Contract Documents, and are suitable for energizing.
 - 1. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.
 - 2. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration.
 - 3. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL

486B.

4. Verify continuity of each conductor.
5. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2.
6. Insulation Resistance Testing: Perform megohm meter tests of all service and feeder circuits, including each phase, neutral, and grounding conductor, as follows:
 - a. Minimum Test Voltage: 1000 Vdc.
 - b. Minimum Insulation Resistance: 1 megohms.
 - c. Duration of Each Test: 1 minute.
 - d. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.
 - e. Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest.
 - f. Prepare reports certified by testing agency identifying equipment checked and describing results of tests. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
7. Infrared Scanning: Perform an infrared scan of each splice and termination in conductors 3 AWG and larger, as follows:
 - a. Remove equipment covers so terminations are accessible to scanner.
 - b. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - c. Provide calibration record for device.
 - d. Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest.
 - e. Prepare reports certified by testing agency identifying equipment checked and describing results of tests. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
8. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

END OF SECTION

SECTION 260526– GROUNDING AND BONDING

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. Refer to Division 26 Section “Conductors and Cables” for conductor and cable requirements.

1.2. SUMMARY

- A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.
- B. Bond the electrical service system neutral at service entrance equipment to grounding electrodes and metallic water service as supplementary.
- C. Bond each separately-derived system neutral to nearest grounding system.
- D. Bond together system neutrals; service equipment enclosures; exposed non-current carrying metal parts of electrical equipment; metal raceway systems; grounding conductor in raceways; receptacle ground connectors; and plumbing systems.

1.3. DEFINITIONS

- A. EGB: Electrical grounding busbar.
- B. EGC: Equipment grounding conductor.
- C. GEC: Grounding electrode conductor.
- D. SSBJ: Supply-side bonding jumper.
- E. TGB: Telecommunications grounding busbar.

1.4. SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for grounding rods, conductors, connectors and connection materials, and grounding fittings. Submit ground system manufacturer's recommended installation procedure for review.
- C. Qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other

information specified.

- D. Field tests and observation reports indicating and interpreting the test reports for compliance with performance requirements, certified by Testing Agency.

1.5. QUALITY ASSURANCE

- A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the International Electrical Testing Association (NETA).
 - 1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 of this Section.
- B. Comply with NFPA 70 - National Electrical Code.
- C. Comply with UL 467 - UL Standard for Safety Grounding and Bonding Equipment.
- D. Comply with ANSI/IEEE C2 - National Electrical Safety Code.
- E. Comply with ANSI/IEEE 32 - Requirements, terms and test procedures for neutral grounding devices.
- F. Comply with IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- G. Comply with ANSI C33.8.
- H. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.6. PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of grounding electrodes and all primary grounding locations (i.e., grounding busbar location(s), water service connection(s), gas service connection, building steel, test wells, etc.)

PART 2. PRODUCTS

2.1. MANUFACTURERS

- 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. Erico Inc.; Electrical Products Group.
2. Harger Lightning and Grounding; Harger, Inc.
3. Heary Brothers Lightning Protection Co.
4. Ideal Industries, Inc.
5. ILSCO.
6. O-Z/Gedney Co.
7. Raco, Inc.
8. Thomas & Betts, Electrical.

2.2. GROUNDING AND BONDING PRODUCTS

- A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3. WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Division 26, Section "Conductors and Cables". Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductors: Size as indicated on the Drawings, or as required by National Electrical Code (NEC) Table 250-122, whichever is larger. Insulated with green color insulation.
- C. Grounding Electrode Conductors: Size as indicated on the Drawings, in the Specifications, or as required by National Electrical Code (NEC) Table 250-66, whichever is larger. Insulated with green color insulation, unless installed in direct contact with earth, in which case conductors shall be bare.
- D. Underground Conductors: Bare, tinned, stranded, 4/0 AWG size minimum, except as otherwise indicated.
- E. Bare Copper Conductors: Conform to the following:
 1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

2.4. MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section, minimum size

¼-inch thick x 4-inches, length as required.

- B. Braided Bonding Jumpers: Copper tape, braided bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, unless otherwise indicated.

2.5. CONNECTOR PRODUCTS

A. Mechanical Connectors

- 1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two-bolt type.
- 2. Split bolt connector types are NOT allowed unless indicated on the Drawings.
- 3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

B. Compression Connectors

- 1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent by IACS Standards.
- 2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
- 3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
- 4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
- 5. Each connector shall be factory filled with an oxide-inhibiting compound.

- C. Exothermic Connections: Provide exothermic-weld kit selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6. GROUNDING ELECTRODES AND TEST WELLS

A. Grounding Rods: Copper-clad rod with rigid steel core.

- 1. Size: ¾ inch by 120 inches (19 by 3000 mm). Provide the number of rods

required to obtain proper ground resistance.

2. Rods shall have a minimum of ten (10) mils of copper.
 3. Ground rods shall be UL listed #467.
- B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch (3 mm) thick, size as indicated.
- C. Test Wells: Fabricate from 15-inch- (400-mm-) long, square-cut sections of 8-inch- (200-mm-) diameter, Schedule 80, PVC pipe. Provide as detailed on Drawings.

PART 3. EXECUTION

3.1. APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
1. Install Equipment Grounding Conductor (EGC) with circuit conductors for the items below in addition to those required by Code:
 - a. Feeder circuits.
 - b. Lighting branch circuits.
 - c. Receptacle branch circuits.
 - d. Single-phase motor or appliance branch circuits.
 - e. Three-phase motor or appliance branch circuits.
 - f. Flexible raceway runs.
 - g. Metal-clad (MC) cable runs.
 2. Busway Supply Circuits: Install separate equipment grounding conductor from the grounding bus in the main distribution panelboard to equipment grounding-bar terminal on busway.
 3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
 4. Water Heater install a separate equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.
- B. Telecommunications System Grounding:
1. Provide one (1) telecommunications grounding bus bar (TGB) in the IT Room. The TGB shall be bonded to the electrical ground bus bar (EGB) in the main electrical room with one (1) 4/0 AWG copper grounding conductor.
- C. Mechanical System Grounding:
1. The incoming domestic water service shall be bonded to the electrical grounding system; provide equipment grounding conductor (EGC) sized per the National

- Electrical Code.
2. The incoming natural gas service shall be bonded to the electrical grounding system; provide equipment grounding conductor (EGC) sized per the National Electrical Code.
 3. All mechanical equipment, including but not limited to pumps, motors, packaged equipment, fans, heaters, etc. and their enclosures shall be properly grounded in accordance with Article 250 of the National Electrical Code.
 4. Terminal Cabinets: Terminate grounding conductor on cabinet grounding
- D. Separately Derived Systems: Ground and bond all separately derived systems in accordance with Article 250.30 of the National Electrical Code, and as follows:
1. Transformers:
 - a. Provide a grounding electrode conductor from the transformer to the nearest grounding electrode, e.g. building steel. Where the grounding electrode conductor is installed within metallic raceway, both ends of the raceway shall be also be bonded.
 - b. Provide a system bonding jumper from the transformer neutral point to the transformer enclosure. The system bonding jumper must remain within the enclosure where it originates.
 - c. Provide a supply-side bonding jumper from the transformer neutral point to the ground bus bar in the first disconnecting means or overcurrent device, e.g. panelboard.
 2. Metal Water Pipe:
 - a. All metal water piping in the area served by the separately derived system shall be bonded to the neutral point of the separately derived system with a bonding jumper in accordance with Article 250.104 of the National Electrical Code.
 - b. Metal water piping is permitted to be bonded to the structural metal building frame in lieu of the neutral point of the separately derived system, if the structural metal serves as the grounding electrode for the separately derived system.
 3. Structural Metal:
 - a. Exposed structural metal in the area served by the separately derived system shall be bonded to the neutral point of the separately derived system with a bonding jumper in accordance with Article 250.104 of the National Electrical Code.
 - b. A separate bonding jumper to structural metal is not required where the structural metal serves as the grounding electrode for the separately derived system.
 4. Grounding and bonding conductors and jumpers shall be sized in accordance with

Table 250.66, Table 250.122 and Article 250.102 of the National Electrical Code.

- E. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

3.2. INSTALLATION

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Bus Bars: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor, except as otherwise indicated.
- C. Grounding Electrodes: Provide a minimum of three (3) grounding electrodes, unless otherwise indicated on the Drawings, in accordance with the following:
 - 1. Locate a minimum of twenty-feet from each other and at least the same distance from any other grounding electrode, unless otherwise indicated on the Drawings.
 - 2. Drive until tops are 24 inches below finished floor or final grade, except as otherwise indicated.
 - 3. Interconnect with grounding-electrode conductors using exothermic welds, except at test wells, unless otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.
- F. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- H. Test Wells: One for each driven grounding electrode, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1-inch- (25-mm-) maximum-size crushed stone or gravel.
- I. The grounded conductor (neutral) of the wiring system shall be connected to the system grounding conductor at a single place in the system by removable bonding jumpers, sized according to the applicable provisions of the National Electrical Code. The grounded

conductor (neutral) connection to the grounding conductor (ground) shall be located in the enclosure for the system's overcurrent protection or where otherwise indicated on the Drawings or Specifications.

- J. Ground buses and neutral buses in all distribution panelboards, branch panelboards, and those provided in any equipment shall be isolated except where required to be connected as specified above for the service entrance and in transformer terminal compartments.
- K. Equipment grounding conductors shall be extended from the ground bus in the distribution equipment to the receptacle, fixture or device lugs where they are provided. When not provided, they shall be connected to equipment enclosures. The connections shall be arranged such that removal of receptacle, the equipment grounding conductors, or ground jumpers from ground busing, shall not affect the system ground.
- L. Ground bus shall be provided as indicated on the Drawings or as necessary to provide termination for equipment grounding conductor. Non-current carrying metal parts of electric equipment shall be effectively grounded by bonding to the bus.
- M. Raceways shall not be considered as a grounding conductor. Each power, lighting, or control raceway shall have a separate equipment grounding conductor installed. Receptacles shall have a separate grounding pole.

3.3. CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor (EGC) Terminations: For 8 AWG and larger, use compression-type grounding lugs. 10 AWG and smaller grounding conductors may be terminated with wire nut connectors as specified in Division 26 Section, "Conductors and

Cables”.

- D. Non-Contact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4. FIELD QUALITY CONTROL

- A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below.
- B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the 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. Perform tests by the 2-point method according to IEEE 81.
- C. Maximum grounding to resistance values are as follows:
 - 1. Equipment Rated 500 kVA and Less: 10 ohms.
 - 2. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3. Equipment Rated More than 1000 kVA: 3 ohms.
- D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to

accomplish recommended work.

- E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit all tests to the Architect for approval.

3.5. ADJUSTING AND CLEANING

- A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION

SECTION 260528 - ELECTRICAL 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. Section includes:
 - 1. Through-penetration firestopping in fire rated construction.
- B. Related items: Raceway seals and manufactured electrical devices: Refer to Division 26 Section, "Raceways and Boxes".

1.3. REFERENCES

- A. Underwriters Laboratories
 - 1. UL Fire Resistance Directory
 - a. Through-penetration firestop devices (XHCR)
 - b. Fire resistance rating (BXUV)
 - c. Through-penetration firestop systems (XHEZ)
 - d. Fill, void, or cavity material (XHHW)
- B. American Society for Testing and Materials Standards: ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4. DEFINITIONS

- A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
- B. Barriers: Time-rated fire walls, time rated ceiling/floor assemblies and structural floors.
- C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.
- D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
- E. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
- F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Refer to Division 26 Section, "Common Work Results for Electrical" for sleeve requirements.

1.5. SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption.

1.6. SUBMITTALS

A. Submit in accordance with Division 01, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.

1.7. QUALITY ASSURANCE

A. Installer's qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
2. At least 2 years experience with systems.
3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

D. Manufacturer shall be a member of the International Firestop Council (IFC).

1.8. DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9. PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced air ventilation during installation if required by manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.10. GUARANTEE

- A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fall in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be two years from date of substantial completion unless otherwise noted.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. Hilti
 2. 3M
 3. Nelson

2.2. THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

- A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrate type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.
1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2. Acceptable manufacturers and products.
 - a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the “System and Applications Schedule” in Part 3 of this Section.
 - b. All firestopping products must be from a single manufacturer.

2.3. ACCESSORIES

- A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.
- B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.
- C. Sleeves: Minimum 24 MSG galvanized steel, 12-inch diameter or smaller steel pipe. Sleeve shall project ½-inch from each surface of the floor/wall. Size as recommended by firestop manufacturer.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2. PREPARATION

- A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3. INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal holes or voids made by penetrations to ensure an effective barrier.
- C. Protect materials from damage on surfaces subject to traffic.
- D. When large openings are created in walls or floors to permit installation of conduits, cable tray, or other items, close unused portions of opening with firestopping materials tested for the application.
- E. Provide sleeves the full thickness of the assembly being penetrated and cut sleeves to a length of 1-inch more than the overall thickness of the penetration, or as recommended by

the firestop manufacturer.

3.4. FIELD QUALITY CONTROL

- A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5. ADJUSTING AND CLEANING

- A. Clean up spills of liquid components.
- B. Neatly cut and trim materials as required.
- C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6. SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP 25WB+	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS-2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	WJ1023 2001		
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195+ CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195+ FC2026 FS-195+ FC2028 FS-195+, 1' & 2-inch WIDE, PPD'S
Insulated Cable	CAJ3001 CP 25N/S, CP 25S/L CAJ3005 CS 195+, FS-195+ CAJ3007 2001 CAJ3009 2000, 2000+, 2003 CAJ3010 2000, 2000+, 2003 CAJ3011 2001 CAJ3014 FD 150 CAJ3015 FD 150 CAJ3021 MPS-2+ CAJ3029 2000, 2000+, 2003 CAJ3030 CP 25WB+ CAJ3031 CP 25N/S, CP 25S/L CAJ3041 2000, 2000+, 2003 CAJ3044 CS-195+, FS-195+ CAJ3058 FS-195+, MPS-2+ CAJ3071 CP 25N/S, CP 25S/L CAJ3074 CP 25N/S, CP 25S/L CAJ3075 2001 CAJ3080 CP 25WB+ CBJ3016 CS-195+, FS-195+ CBJ3017 CS-195+, MPS-2+ FA3001 CP 25WB+ FB3004 CS-195+, MP WJ3015 2001 WJ3016 2001	WL3001 CP 25, MPS-2+ WL3008 2000+ WL3009 2000+ WL3015 CP 25WB+, CP 25N/S WL3022 2000+ WL3030 FS-195+ WL3031 MPS-2+ WL3032 CP 25WB+ WL3041 2000+ WL3051 CP 25N/S WL3056 CP25N/S WL3062 CP 25WB+	FC3001 CP 25S/L, CP 25N/S FC3002 2000+ FC3003 2000, 2000+, 20003 FC3007 CP 25WB+, MPS-2+ FC3008 FS-195+
Mixed Penetrating Items Combos	CAJ8001 CS-195+ FS-195+ CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001	WL8002 CS-195+, FS-195+	

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	FA8001 FS-195+, CP 25WB+		

*Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

SECTION 260529 – HANGERS AND SUPPORTS

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. Requirements of the following Sections apply to this Section:
 - 1. Division 26 Section, “Common Work Results for Electrical” for general installation requirements.

1.2. SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Provide equipment supports consisting of concrete pads, structural members, hangers, rods, racks, and incidental materials.
- C. Provide all labor, supervision, and fabrication. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas. Provide all engineering and fabrication as required for installation of support system.
- D. Provide hangers, clamps, anchors, inserts, supports, supplementary steel framing, and hardware of the proper size and load capacity to support electrical equipment and raceways, whether indicated on the drawings or not.

1.3. SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 01 Specification Sections.
- B. Product data for each type of product specified.
- C. Supporting devices and fastening methods shall be subject to the review and approval of the Structural Engineer.

1.4. QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 National Electrical Code.
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party Certification follow-up services.
- C. Installation Standard: Installation shall meet or exceed the National Electrical Contractors Association (NECA) Standard of Installation.

- D. Manufacturer's Qualifications:
 - 1. The Manufacturer shall not have had less than ten years' experience in manufacturing Strut Support Systems.
 - 2. The Manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.
- E. All Strut Support System components must be supplied by a single manufacturer.
- F. Standards:
 - 1. Work shall meet the requirements of the following standards:
 - a. Federal, State and Local Codes.
 - b. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members.
 - c. American Society for Testing and Materials (ASTM).
 - d. Underwriters Laboratories (UL).
 - e. National Electrical Code (NEC).

1.5. PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All material is to be delivered to the work site in original factory packaging to avoid damage to the finish.
- B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

1.6. GUARANTEE

- A. Separate guarantees shall be issued from the erector and manufacturer, valid for a period of one year against any defects that may arise from the installation or manufacture of the Strut Support System components.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. American Electric, Kindorf
 - b. Alstrut
 - c. Unistrut Diversified Products
 - d. Power-Strut
 - e. Thomas & Betts

2.2. COATINGS

- A. Dry, Interior Locations: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion-resistance using approved alternative treatment, finish, or inherent material characteristic. All products installed in dry interior locations shall be hot-dip galvanized, unless otherwise noted.
- B. Damp or Wet Locations: Supports, support hardware, and fasteners installed in damp or wet locations, including exterior locations, shall be Type 304 stainless steel.

2.3. MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features, as follows:
 - 1. Expansion Anchors - Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts - All steel springhead type.
 - 3. Power-Driven Threaded Studs - Heat-treated steel, designed specifically for the intended application.
- C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- D. U-Channel Systems: Sixteen-gauge channels with 9/16-inch-diameter slotted holes at a minimum of two inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.
- E. Concrete Equipment Pads:
 - 1. Refer to Division 26 Section "Common Work Results for Electrical" for installation requirements.
- F. Floor-Mounted Stands: Construct with structural steel members or steel pipe and fasten with flanges bolted to the floor.
- G. Wall-Mounted Platforms: Construct with steel brackets.

2.4. ANCHOR METHODS

- A. Hollow Masonry: Toggle bolts or plastic conical type expansion anchors.
- B. Solid Masonry: Lead expansion anchors or preset inserts.
- C. Metal Surfaces: Machine screws, bolts, or welded studs.
- D. Wood Surfaces: Wood screws.
- E. Concrete Surfaces: Self-drilling anchors or power-driven studs

2.5. VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad)

1. Neoprene pad isolators shall be formed by two layers of ¼-inch to 1/16-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. Layers shall be permanently adhered together. Pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:
 - a. Type NR: Amber/Booth.
 - b. Type Korpad: Korfund Dynamics.
 - c. Type WSW: Mason Industries.
 - d. Type NPS: Peabody Noise Control.
 - e. Series Shear Flex: Vibration Mountings and Control.

PART 3. EXECUTION

3.1. EXAMINATION

- A. The installer shall inspect the work area prior to installation. If work area conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

3.2. INSTALLATION

- A. Set Strut System components into final position true to line, level and plumb, in accordance with approved Shop Drawings.
- B. Anchor material firmly in place. Tighten all connections to their recommended torques.
- C. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- D. Coordinate with the building structural system and with other electrical installation.
- E. Raceway Supports: Comply with the NEC and the following requirements:
1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 6. Space supports for raceways in accordance with Table I of this Section. Space supports for raceway types not covered by the above in accordance with NEC.
 7. Support exposed and concealed raceway within one foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminations are not made with chase nipples or threadless box connectors.
 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminations.
- F. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting disconnects, light fixtures, and other devices.
- G. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including, but not limited to conduits, raceways, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.

4. Concrete: Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.
- I. General Supporting Installations:
1. Provide appropriate concrete anchors for hanger rods. Rods shall be screwed into or extended through frame construction (with washer and nut). Supports shall secure conduit in place, and shall prevent vibration, provide for expansion and contraction and shall make neat appearance. Strap hangers or chains are not permitted.
 2. Electrical raceways 1-1/2-inches and smaller shall be secured with 1-hole malleable iron straps or brackets to walls. Trapeze supports shall be used for groups or parallel raceways with raceways secured to trapeze with approved clamps. Individual runs of raceways 2-inches and larger shall be supported by Clevis type hangers.
 3. Provide all steel supports including roof curbs for all equipment provided under this Section.
 4. Electrical raceway supports to be spaced on the following maximum centers, unless otherwise required by the NEC:
 - a. 3/4-inch to 1-inch conduit - 8 feet
 - b. 1-1/4-inch and larger conduit - 10 feet
- J. Provide additional hangers or steel members to distribute the load among two or more structural members when required or directed.
- K. Drilling of new concrete slabs will not be permitted. Anchors and inserts shall be cast in the concrete slabs.
- L. Locations:
1. Anchor bolts, sleeves, inserts, hangers, and supports required for the electrical work shall be furnished and installed under Division 26.
 2. Coordinate with other trades the location of anchors, sleeves, inserts, and supports and insure that they are properly installed.
 3. Openings and sleeves shall be set true to line, level, plumb, and position and shall be set true to line, level, plumb, and position and shall be so maintained during construction. Where sleeves and openings are provided in poured concrete, inspect same during and after concrete is poured to insure proper position and correct any deviation.
- M. Hangers and Supports:
1. Provide hangers, angles, channels, and other supports required by field conditions to install items of electrical equipment. Design of supports and methods of fastening to building structure shall be acceptable to the Owner.

2. Use of power-actuated fasteners and devices is permitted in the vertical surfaces of the building only with the following requirements.
 - a. For fastening conduits 1-1/2-inch and smaller and lighting fixtures 50 lbs or less.
 - b. Load capacity per manufacturers' recommendations.
 - c. Fasteners shall be located in the thickest part of the slab.
 - d. Devices shall comply with OSHA requirements.
3. Use of lead shield expansion anchors is not permitted.
4. No electrical items shall rest on, or depend for support on suspended ceiling media (tiles, lath, plaster, splines, etc.).
5. In spaces with suspended ceilings, support conduits directly from structural slabs, decks (or framing members). Do not support conduits on ceiling suspension members.
6. Support surface or pendant lighting fixtures:
 - a. From an outlet box by means of an interposed metal strap, where weight is less than 5 lbs.
 - b. From an outlet box by means of a hickey or other direct threaded connection, where weight is from 5 to 50 lbs.
 - c. Directly from structural slab, deck or framing member, where weight exceeds 50 lbs.
7. In addition to the above, provide cushioned, swivel type hangers with appropriate outlet boxes for pendant fixtures in mechanical areas. Such hangers shall have a support rating at least twice that of the load supported.
8. Support recessed lighting fixtures directly from structural slab, deck, or framing members. Refer to Division 26 Section "Interior Lighting" for additional installation requirements.
9. Provide weight-distribution facilities, where required so as not to exceed the load bearing capabilities of floor or walls that bear the weight of, or support, electrical items.
10. For point-of-attachment weight of 100 lbs. or less, fasten items as follows:
 - a. On wood, use wood screws.
 - b. On concrete and solid masonry that is already in place, use self-drilling concrete anchors or expansion bolt and couplings.
 - c. On hollow construction, use toggle bolts.
 - d. On structural steel, use beam clamps.
11. For point-of-attachment weights from 100 lbs. to 300 lbs., provide supports as follows:
 - a. At cast-in-place concrete slabs, use concrete inserts in bottom of slab, with

- 8" slip-through steel rods set transverse to the reinforcing steel.
- b. At concrete slab already in place, uses 16-inches x 8-inches x ½-inch steel plates at the top of the slab, with through-bolts welded in place. The plates shall be chased in and grouted flush, where no fill is to be applied.
12. For point-of-attachment weights over 300 lbs., provide supports as follows: At cast-in-place concrete slabs, uses 16-inch x 8-inch x ½-inch steel plate, with through bolts welded in place. Top of the plate shall be 1-1/2-inches below the top of the slab or on top of the slab where a fill slab is to be installed.
13. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
14. Trapeze type hangers may be used where several conduits are to be installed at the same elevation. The spacing of such trapeze hangers shall be in accordance with the NEC for the smallest conduit in the run.
15. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored to construction at each floor.
- N. Inserts:
1. Inserts for suspended items in poured concrete construction shall be malleable-iron concrete inserts, adjustable type with insert nut. Items manufactured by Barrett, Crawford, Elcen, or Grinnell shall be used where applicable.
2. Inserts for surface-mounted items shall be suitable for the composition of the slab, wall, or structure on which installation is to be made.
- O. TABLE I: SPACING FOR RACEWAY SUPPORTS

TABLE I: SPACING FOR RACEWAY SUPPORTS				
Raceway Size (Inches)	No. of Conductors in Run	Location	PVC & RGS (Ft.)	EM T (Ft.)
		HORIZONTAL RUNS		
1/2, 3/4	1 or 2	Flat ceiling or wall.	5	5
1/2, 3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7
1/2, 3/4	3 or more	Any location.	7	7
1/2 - 1	3 or more	Any location.		
1 & larger	1 or 2	Flat ceiling or wall.	6	6
1 & larger	1 or more	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location.	10	10
Any	---	Concealed.	10	10
		VERTICAL RUNS		
1/2, 3/4	---	Exposed.	7	7
1, 1-1/4	---	Exposed.	8	8
1-1/2 & larger	---	Exposed.	10	10
Up to 2	---	Shaftway.	14	10

2-1/2	---	Shaftway.	16	10
3 & larger	---	Shaftway.	20	10
Any	---	Concealed.	10	10
Abbreviations:	EMT	Electrical Metallic Tubing		
	PVC	Rigid Polyvinyl Chloride Conduit		
	RGS	Rigid Galvanized Steel Conduit		

3.3. CLEANUP

- A. Upon completion of this Section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

3.4. PROTECTION

- A. During installation, protect this work from damage.
- B. Upon completion of this scope of work, it shall become the responsibility of the General Contractor to protect this work from damage during the remainder of construction on the project and until substantial completion.

END OF SECTION

SECTION 260533 RACEWAYS AND BOXES

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. Related Sections include the following:
 - 1. Division 26 Section "Conductors and Cables" for conductors installed in raceways and boxes and conductor terminations.
 - 2. Division 26 Section "Electrical Firestopping" for requirements for firestopping at penetrations through walls and floors that are fire barriers.
 - 3. Division 26 Section "Hangers and Supports" for raceways and box supports.
 - 4. Division 26 Section "Underground Ductbanks" for raceways installed in ductbanks and for ductbanks accessories.
 - 5. Division 26 Section "Wiring Devices" for devices installed in boxes.
 - 6. Division 27 Section, "Miscellaneous Raceway Systems" for raceways and box requirements for communications cabling.

1.2. SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
 - 1. Raceways include the following:
 - a. EMT
 - b. FMC
 - c. LFMC
 - d. LFNC
 - e. PVC
 - f. PVC externally coated, rigid steel conduits
 - g. RGS
 - h. RMC
 - i. RNC
 - j. Wireways
 - 2. Boxes, enclosures, and cabinets include the following:
 - a. Device boxes
 - b. Outlet boxes
 - c. Pull and junction boxes
 - d. Cabinets and hinged cover enclosures

3. Miscellaneous Products include the following:
 - a. Expansion/Deflection fittings
 - b. Bushings

1.3. DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FMC: Flexible Metal Conduit.
- C. LFMC: Liquidtight Flexible Metal Conduit.
- D. LFNC: Liquidtight Flexible Nonmetallic Conduit.
- E. PVC: Rigid Polyvinyl Chloride Conduit.
- F. RGS: Rigid Galvanized Steel Conduit.
- G. RMC: Rigid Metal Conduit.
- H. RNC: Rigid Nonmetallic Conduit.

1.4. SUBMITTALS

- A. Product Data: For raceways, wireways and fittings, hinged cover enclosures, and cabinets.
- B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.5. QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation" and NECA 101 "Recommended Practice for Installing Steel Conduits".
- C. Comply with NFPA 70.

1.6. COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.
- B. Verify routing and termination locations of conduits and boxes prior to rough-in.

- C. Conduit routing shown on Drawings is only approximate and diagrammatic. Route conduits as required for a complete conduit and wiring system.
- D. Coordinate final locations, mounting heights, and orientation of all outlet, junction, and pull boxes.
- E. Coordinate mounting heights and locations of outlet boxes thoroughly with approved casework shop drawings.

1.7. PROJECT RECORD DOCUMENTS:

- A. Accurately record routing of all concealed conduits. Record actual routing of all exposed conduits/larger than 1 inch. Indicate actual locations and mounting heights of outlet boxes, pull and junction boxes, branch circuits, arrangements, etc.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- 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. Metal Conduit and Tubing:

- a. Allied Tube & Conduit Corporation.
- b. Anamet, Inc.; Anaconda Metal Hose.
- c. AFC/Monogram Company.
- d. Carol Cable Co., Inc.
- e. Cole Flex Corp.
- f. Electri Flex Co.
- g. Flexcon, Inc.; Coleman Cable Systems, Inc.
- h. Grinnell Co.; Allied Tube and Conduit Div.
- i. Monogram Co.; AFC.
- j. Spiraduct, Inc.
- k. Triangle PWC, Inc.
- l. Wheatland Tube Corporation

2. Nonmetallic Conduit and Tubing:

- a. Anamet, Inc.; Anaconda Metal Hose.
- b. Arnco Corp.
- c. Breeze Illinois, Inc.
- d. Cantex Industries; Harsco Corp.
- e. Certainteed Corp.; Pipe & Plastics Group.
- f. Cole Flex Corp.
- g. Condux International; Electrical Products.
- h. Electri Flex Co.
- i. George Ingraham Corp.
- j. Hubbell, Inc.; Raco, Inc.
- k. Lamson & Sessions; Carlon Electrical Products.

- l. R&G Sloan Manufacturing Co., Inc.
 - m. Spiraduct, Inc.
 - n. Thomas & Betts Corporation
3. Conduit Bodies and Fittings:
- a. American Electric; Construction Materials Group.
 - b. Crouse Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.
 - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. Z/Gedney; Unit of General Signal.
 - g. Scott Fetzer Co.; Adalet PLM.
 - h. Spring City Electrical Manufacturing Co.
 - i. Thomas & Betts Corporation.
4. Metal Wireways:
- a. Hoffman Engineering Co.
 - b. Keystone/Rees, Inc.
 - c. Square D Co.
5. Nonmetallic Wireways:
- a. Hoffman Engineering Co.
 - b. Lamson & Sessions; Carlon Electrical Products.
 - c. Wiremold Co.
 - d. Hubbell
6. Boxes, Enclosures, and Cabinets:
- a. American Electric; FL Industries.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Crouse Hinds; Div. of Cooper Industries.
 - d. Electric Panelboard Co., Inc.
 - e. Erickson Electrical Equipment Co.
 - f. Hoffman Engineering Co.; Federal Hoffman, Inc.
 - g. Hubbell Inc.; Killark Electric Manufacturing Co.
 - h. Hubbell Inc.; Racor, Inc.
 - i. Lamson & Sessions; Carlon Electrical Products.
 - j. Z/Gedney; Unit of General Signal.
 - k. Parker Electrical Manufacturing Co.
 - l. Robroy Industries, Inc.; Electrical Division.
 - m. Scott Fetzer Co.; Adalet PLM.
 - n. Spring City Electrical Manufacturing Co.
 - o. Thomas & Betts Corp.
 - p. Woodhead Industries, Inc.; Daniel Woodhead Co.

2.2. METAL CONDUIT AND TUBING

- A. EMT and Fittings: Hot galvanized steel O.D. with an organic corrosion-resistant I.D.

coating. Listed to UL Safety Standard 797 and manufactured in accordance with ANSI C80.3.

1. Fittings: Compression type, NEMA FB1.
- B. FMC: Zinc coated steel.
- C. LFMC: Flexible steel conduit with PVC jacket.
- D. RGS: ANSI C80.1 and UL 6.
- E. Plastic Coated Steel Conduit and Fittings: NEMA RN 1.
- F. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3. COLORED METAL CONDUIT AND TUBING

- A. EMT: Hot galvanized steel O.D. with vibrant color top coat and an organic corrosion-resistant I.D. coating. Listed to UL Safety Standard 797 and manufactured in accordance with ANSI C80.3.
- B. Provide True Color® EMT as manufactured by Allied Tube and Conduit, or approved equal by listed manufacturer.

2.4. NONMETALLIC CONDUIT AND TUBING

- A. PVC: NEMA TC 2, UL 651, Schedule 40 or 80.
- B. PVC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. LFNC: UL 1660.

2.5. METAL WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.
- B. 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.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Screw cover type.
- E. Finish:
 1. Dry Interior Locations: Manufacturer's standard enamel or galvanized finish, NEMA 1.
 2. Damp/Wet Locations: ANSI 49 gray polyester over phosphatized steel, NEMA 3R.

2.6. OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized flat-rolled sheet steel.
- B. Cast Metal Boxes: NEMA FB 1, Type FD, cast box, deep type, with gasketed cover, and threaded hubs.
- C. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including corrosion-resistant screws, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.
- D. Nonmetallic: NEMA OS2.

2.7. PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1, galvanized flat-rolled sheet steel.
- B. Sheet metal boxes over 12" in any dimension shall comply with the requirements of Article "Enclosures and Cabinets" of this Section.
- C. Boxes for Outdoor and Wet Locations: Flat flanged, surface-mounted, UL listed as raintight, galvanized cast iron box and cover with neoprene gasket and stainless steel cover screws.
- D. Boxes for Buried Flush Grade Locations: Refer to Division 26 Section, "Utility Holes" for product requirements.

2.8. BOX EXTENSIONS

- A. Prohibited on new construction.
- B. Where more than one box is needed to flush out installation, provide a large (i.e., 6" x 6") box to flush out the existing box and nipple over to a new box.

2.9. BUSHINGS

- A. Bushings shall be self-extinguishing thermoplastic type with 105 degrees C (minimum) temperature rating.
- B. Bushings with grounding lugs shall be malleable iron body with 105 degrees C (minimum) insulating ring. Insulating material shall be locked in place and non-removable.

2.10. EXPANSION / DEFLECTION FITTINGS

- A. Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeves, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.

- B. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:
 - 1. Axial expansion or contraction up to 3/4-inch.
 - 2. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
 - 3. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.
- C. Expansion/Deflection fitting shall be OZ/Gedney Type "DX" or approved equal by Crouse Hinds (Type XD).

2.11. ENCLOSURES AND CABINETS

- A. Hinged Cover Enclosures: NEMA 250, Type 1 in dry locations, and Type 4 in wet or damp locations, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. RACEWAY AND BOX REQUIREMENTS

- A. Conduit Application Schedule:

APPLICATION	CONDUIT TYPE	REMARKS
In or under concrete slab	RNC (Schedule 40 PVC)	Use RGS elbows/sweeps to stub up through slab, unless otherwise noted on the drawings. Coat RGS with (2) two heavy coats of asphaltum.
Exposed exterior locations.	RGS	Use threaded or rain-tight fittings and stainless steel hardware.
Damp/Wet interior locations.	RGS	Use threaded or rain-tight fittings and stainless steel hardware.
Exposed dry interior locations	EMT, RGS	Schedule 40 PVC is acceptable for concealing grounding electrode conductors, except for plenum spaces. Provide RGS conduit where subject to physical damage.

APPLICATION	CONDUIT TYPE	REMARKS
Exterior underground.	RNC (Sched. 40 PVC)	RGS Elbows/Sweeps unless otherwise noted on the Drawings. Coat RGS with (2) two heavy coats of asphaltum.
Equipment connections in dry interior locations.	FMC (e.g. Greenfield)	Short lengths only (maximum 6 feet).
Equipment connections in wet interior locations.	LFMC (e.g. Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings and stainless steel hardware.
Equipment connections in exterior locations.	LFMC (e.g. Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings and stainless steel hardware.
Concealed in dry wall construction.	EMT, MC Cabling	Refer to Section 260519 "Conductors and Cables" for MC Cable Requirements.
Concealed above suspended ceilings.	EMT, MC Cabling	Refer to Section 260519 "Conductors and Cables" for MC Cable Requirements.
Concealed in masonry walls.	EMT	

B. General Requirements

1. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) for exposed work in locations subject to physical damage,.
2. Aluminum conduit is prohibited.
3. Where rigid non-metallic conduit is exposed, it shall be Schedule 80 PVC, with all provisions for thermal expansion/contraction as recommended by the Manufacturer.
4. Conduits for exterior underground electric work shall be rigid steel, galvanized and sherardized, leaving the building and to points 5 feet beyond footings. Beyond 5 feet of building, underground conduits shall be non-metallic Schedule 40 PVC, Type II.
5. All steel conduits below grade or in contact with earth shall be painted with two heavy coats of asphaltum.
6. Conduits shall slope from entrance equipment toward outside of building.

C. Fittings:

1. All fittings to match conduit material and to be suitable for the purpose intended. Join conduit with fittings designed and approved for the purpose and make joints tight.
2. Provide UL listed compound filled sealing fittings for NEC-required locations, for conduits passing from interior to exterior, and at the interface of widely different space temperatures such as refrigeration or cold storage rooms where conduits pass

from warm locations to cool locations, such as the boundaries of air conditioned spaces and non-conditioned air spaces. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction. Provide expansion fittings in each straight uninterrupted run of surface-mounted conduit, both horizontal and vertical, in excess of 200 feet. Distance between fittings shall not exceed 200 linear feet. The Contractor shall refer to the Architectural Drawings for expansion joint locations.
4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ/Gedney type "B", or equal.
5. Fasten EMT conduit with concrete-tight or rain-tight compression fittings made from zinc-plated steel. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.
6. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.
7. Fasten Flexible Metallic Conduit (FMC) with Thomas & Betts (T&B) "Tite-Bite" insulated connectors, or equal.
8. Watertight fittings shall use a copper base anti-corrosive conductive compound. Provide watertight fittings for conduits in damp or wet locations, underground locations, and in floor slabs.

D. Box Locations:

1. Electrical boxes shall accommodate wire pulling, splices, taps, equipment connections and Code compliance.
2. Coordinate access doors as required to provide access to boxes in hard ceilings and similar inaccessible areas.

E. Outlet Boxes:

1. Outlet boxes for dry interior locations and for concealed work shall be zinc-coated or cadmium-plated sheet steel boxes suitable for the service and type outlet.
2. Boxes and conduit fittings for damp or wet locations and exposed locations subject to damage shall be NEMA 4 cast-aluminum, cast steel or cast iron type with gasketed cover plates and threaded hubs for conduit entrance.
3. Extra large boxes shall be provided in accordance with the National Electrical Code where necessary to prevent crowding of wire in the box.

4. Plastic boxes and cast "white metal" boxes classified as NEMA 4 will not be acceptable.
 5. Outlet boxes in unplastered brick or block walls shall be provided with deep square-cut device covers. They shall be set so that the brick or block can be cut and fitted closely to the cover opening and so that the standard wall plate will cover the joint between the brick or block and the box.
 6. All outlet boxes used for supporting fixtures shall be furnished with malleable iron fixture studs of "no-bolt" type secured by locknut.
 7. Provide support for boxes occurring in suspended ceilings. Outlets in ceilings directly on bottom of joists shall be supported independent of ceiling construction. Outlets in suspended ceilings shall not be supported from ceiling construction.
 8. All boxes, whether outlet, junction, pull, or equipment, shall be furnished with appropriate covers.
 9. No sectionalized boxes shall be used.
 10. Back-to-back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and a minimum of 2 feet in acoustical walls.
 11. Provide factory-made knockout closures for unused openings in outlet boxes.
 12. Provide blank coverplates for all unused boxes.
 13. For multiple device installations, provide multi-gang boxes. Sectional boxes are not permitted. Provide barrier separation of different voltage conductors in the same box.
 14. Thoroughly coordinate mounting heights of boxes with casework and backsplash heights.
 15. Provide recessed outlet boxes in finished areas, supported from interior partition studs. Supports are to be stamped steel stud bridges for hollow stud walls and adjustable steel channel fasteners for flush ceiling outlet boxes.
 16. Provide back supports for boxes in metal stud walls.
- F. Junction and Pull Boxes:
1. Junction and pull boxes shall be furnished and installed as shown or where required to facilitate pulling of wires or cables. Such boxes shall be installed in accessible locations. All boxes for concealed work shall be constructed of 12 gauge USS galvanized sheet steel minimum, unless otherwise specified or indicated and provided with mounting brackets and flat screw covers secured in position by round head brass or stainless steel 300 grade machine screws. Boxes for exterior work shall be cast aluminum or galvanized cast iron type with threaded hubs unless otherwise directed. Gasketed cover plates shall be furnished for outdoor installation.

2. Provide barrier (separators) where different system voltage share the same box.
3. Wherever possible, locate pull and junction boxes above accessible ceilings in finished areas.
4. Pull or junction boxes shall be supported independently of conduit.

3.3. INSTALLATION OF RACEWAYS

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Furnish and install a separate and independent raceway system as shown on the Drawings for each of the various wiring systems including, but not limited to, the following:
 1. Communications System
 2. Control Wiring
 3. Fire Alarm System
 4. Incoming Telephone Service
 5. Incoming Electric Service
 6. Incoming CATV System
 7. Lighting
 8. Power 120/208 volt
 9. Power 277/480 volt
 10. Security System
 11. Telephone Wiring
- C. All raceway systems shall be completely wired as specified herein, shown on drawings and/or required for satisfactory operation of the various systems.
- D. Raceways, generally, shall be concealed conduit as specified herein. Where wiring troughs are required or used to facilitate the wiring installation, they shall be equal to Square D Company's Square-Duct and fittings, with hinged cover arranged for total removal, all finished in baked enamel and all components U/L listed. The gutters shall be of ample size to accommodate conductors therein and as required by the NEC.
- E. Support all conduit not embedded in concrete or masonry such that strain is not transmitted to outlet boxes and pull/junction boxes, etc. Supports to be sufficiently rigid to prevent distortion of conduits during wire pulling.
- F. Minimum Raceway Size:

1. 3/4 inch trade size for interior work
 2. 1-inch trade size for exterior underground work.
- G. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
- H. Communications, Automatic Temperature Control (ATC), Fire Alarm, and Security system wiring shall be installed in raceways within partitions, terminated 8" above accessible ceiling with 90 degree bend with insulating bushing on the end. Free-run cabling above accessible ceilings shall be supported by J-hooks and/or bridle rings at required spacing intervals. Cabling above inaccessible ceilings and in exposed locations shall be installed completely in raceway.
- I. Wiring above ceiling shall be plenum rated cable, where required by Code.
- J. Wiring installed concealed above hard ceilings and exposed in areas with no ceilings shall be installed in conduit.
- K. Conduit shall be run concealed wherever possible, within walls, ceilings, or floors, unless otherwise indicated or specified. Where exposed conduits runs are shown or required, they shall be run parallel to building construction and shall be suitably supported at required intervals.
- L. Conduit may be run exposed in Mechanical Equipment rooms, Electrical rooms, and where necessary in Storage rooms and unfinished areas. Where conduit is run exposed, it shall be run as close as possible to walls and ceilings and shall not interfere with equipment, ductwork and piping.
- M. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues, steam or hot water pipes and other hot surfaces above 77 degrees F. Install horizontal raceway runs above water and steam piping.
- N. Install raceways level and square and at proper elevations. Provide adequate headroom.
- O. Complete raceway installation before starting conductor installation.
- P. Support raceways as specified in Division 26 Section "Hangers and Supports". Arrange supports to prevent misalignment during wiring installation.
- Q. Use capped bushings or "push-penny" plugs to prevent foreign matter from entering the conduit system during construction. Clean and plug or cap all conduits left empty for future use.
- R. Protect stub ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Conduit stub-ups and stub-downs shall be arranged in a neat and orderly manner and shall emerge at right angles to floors or ceilings.
- S. Make bends and offsets so the inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

- T. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- U. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated/
- V. Conduits may be installed in concrete floor slabs with the following limitations:
 - 1. Maximum size –1-1/4".
 - 2. Minimum concrete cover – 1", above and below.
 - 3. Minimum spacing between conduits - 6" on center.
 - 4. Conduit outside diameter - 1/3 of slab thickness, maximum.
 - 5. Installed between bottom and top reinforcing, and centerline of conduit at the mid-depth of the slab.
 - 6. Secured to prevent possible change in position, sagging, or shifting as concrete is poured.
 - 7. Water or damp-proofing integrity of slab is not disturbed.
 - 8. Conduits larger than 1-1/4" may be installed in [grade level] concrete floor slabs only with the specific permission of the Engineer, or as specifically indicated on the drawings, all in accordance with the above limitation.
 - 9. Conduits in close proximity to each other at panelboards, etc., shall be located and wrapped with wire mesh to prevent cracking of slab.
 - 10. Transition non-metallic tubing to rigid steel conduit before rising above the floor.
 - 11. Space raceways laterally to prevent voids in the concrete.
 - 12. Run conduit parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
- W. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
- X. Run parallel or banked raceways together, on common supports where practical.
- Y. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- Z. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.
- AA. Tighten set screws of threadless fittings with suitable tools.
- BB. Install pull wires in empty raceways. Use 14 AWG zinc coated steel or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- CC. Stub up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver operated, threaded flush plugs flush with floor for future equipment connections.
- DD. Lubricants for pulling wires shall be approved for use with the types of wire and conduit installed.
- EE. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- FF. Use conduit hubs to fasten conduit to boxes in damp and wet locations.
- GG. All metal raceways for circuits over 250-volts to ground shall be bonded per NEC Article 250.97.
- HH. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inches (50 mm) in size.
- II. Avoid moisture traps; provide junction box with drain fittings at low points in conduit system.
- JJ. Die-cast fittings of pot metal will not be accepted.
- KK. Conduits shall be free of any burrs, foreign objects, and water prior to conduit installation.
- LL. Conduit placed against concrete or masonry above ground shall be fastened to the concrete or masonry with pipe straps or one screw clamp attached to the concrete by means of expansion screw anchors and screws. "Caddy Clip" type hangers or straps will be permitted only in non-exposed areas and restricted to 3/4" conduit.
- MM. Where conduits turn up out of concrete slabs and are not concealed by wall construction, bends shall be carefully made so that no portion of the radius is above the floor.
- NN. Rigid conduit or Electrical Metallic Tubing (EMT) shall not be strapped or fastened to equipment subject to vibration or mounted on shock-absorbing bases.
- OO. Conduit shall be installed in such manner as to ensure against the collection of trapped condensation, and runs of conduit shall be without traps wherever possible. Drill 1/8" diameter weep holes where necessary.
- PP. Conduits run to and from cabinets shall be run neatly, in accurate manner and shall emerge

from the floors and ceilings at right angles thereto.

- QQ. Provide wall flanges and gasketing on conduits entering fan housings to minimize air leakage at points of penetration of housing.
- RR. Conduit risers shall be rigidly supported on the building structure, using appropriate supports only.
- SS. Exposed conduit installed on or adjacent to ventilating ducts shall be installed after the ducts are in place, and shall be run from ceiling or wall junction boxes in such manner as to retain accessibility to junction box covers and to permit future removal or replacement of ducts.
- TT. Conduits and other electrical items shall not be fastened to, or supported from ventilating ducts but shall be separately supported. The method of supporting and details of the supporting members shall be reviewed by the Owner's Representative. In no case shall screws penetrate the sheet metal of the ducts.
- UU. Exposed conduit run on surface shall be supported according to Code and within three feet of each outlet, junction box, or cabinet, by galvanized malleable conduit clamps and clamp backs. Suspended conduits shall be supported every five feet by conduit hangers and round rods, or where two or more conduits are run parallel, by trapeze hangers suitably braced to prevent swaying.
- VV. Screws and other hardware for all work in damp/wet locations shall be stainless steel, unless otherwise noted.
- WW. Zinc coated galvanized steel screws may be used for interior dry locations only.
- XX. No running threads shall be cut or used.
- YY. Conduits which are installed at this time and left empty for future use and which are five feet or more in length, including all telephone and communication conduits shall have a non-ferrous, 600 lb. tensile strength drag line left in place for future use. All empty conduits including conduit stubs shall be tagged at all exposed ends with tags identifying the location of the end of the conduit.
- ZZ. In all instances where flush-mounted type panelboards are installed, provide spare (empty) conduits in accordance with schedule in Division 26 Section "Panelboards", Paragraph "Provision for Future Circuits at Flush-Mounted Panelboards". These conduits shall extend between the panelboard cabinet and a junction box located above accessible ceiling construction.

3.4. INSTALLATION OF BOXES

- A. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.
- B. Set floor boxes level and adjust to finished floor surface.

- C. Provide junction boxes, pull boxes, cable support boxes, and wireways as required for proper installation of the electrical work. Covers shall be accessible. Small junction boxes shall be similar to outlet boxes. Provide barriers (separators) where different system voltage wires share the same box.
- D. Pull boxes, cable support boxes, and large junction boxes for indoor use shall be made of Code gauge steel or no less than 12 gauge. Covers shall be held in place with zinc-coated galvanized steel screws. Paint interior and exterior surfaces with rust-inhibitive paint. (Pull boxes and covers shall be hot-dipped galvanized.)
- E. Boxes located outdoors and in damp or wet locations shall be cast metal or alloy, fitted with screw-fastened covers and gaskets, and with threaded conduit connections. Fasteners shall be stainless steel.
- F. Pull boxes shall be installed at all necessary points to facilitate pulling of wires and to prevent injury to the insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Pull box locations shall be approved by the Owner's representative prior to installation.
- G. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flat head machine screws shall be used.
- H. Pull boxes with barriers shall have a single cover plate and the barriers shall be of the same gauge as the pull box.
- I. Exposed pull boxes will not be permitted in finished spaces.
- J. Location of pull boxes shall be coordinated with piping, ductwork, and other equipment so as to permit sufficient clearance for maintenance and access.
- K. Pull boxes recessed in walls or partitions shall be provided with flanged type covers.
- L. Outlet boxes and covers shall be of proper Code size for the number of wires and/or conduits passing through or terminating therein, but in no case shall any box be less than 4" square.
- M. Outlet boxes for lighting fixtures shall be equipped with fixture supporting devices.
- N. Outlet boxes for switches shall be of the gang type.
- O. Each circuit in each pullbox shall be marked with a tag guide denoting panels to which they connect.
- P. Boxes shall be separated to prevent sound transmission. Back-to-back boxes shall not be used.
- Q. Outlet boxes shall be provided with suitable plaster rings and covers or plates.
- R. Unused knockout holes shall remain closed and those opened by error shall be closed with approved factory-made knock-out seals.
- S. Outlet boxes installed in plenum ceilings shall be in accordance with applicable codes.

- T. Outlet boxes shall be installed true and plumb so that the covers or plates will be level and at uniform elevations for the types of outlets contained.
- U. Outlet boxes for toggle switches at doorways shall be located at the strike side of the door as finally hung.
- V. Outlet box locations as indicated shall be considered to be approximate only. Determine exact locations from architectural details or from field instructions and coordinate outlet box locations with the work of other trades.
- W. Install junction and pull boxes to be accessible.
- X. Locations of junction and pull boxes requiring access panels shall be reviewed by the Owner's Representative.
- Y. Install hinged-cover enclosures and cabinets plumb. Support at each corner at minimum.

3.5. INSTALLATION OF TERMINATIONS

- A. Where raceways are terminated with lock nuts and bushings, align the raceway to enter squarely, and install the lock nuts with dished part against the box. Where terminations cannot be made secure with one lock nut, use two lock nuts, one inside and one outside of the box.
- B. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- C. Open ends shall be capped with approved manufactured conduit seals as soon as installed and kept capped until ready to pull in conductors.
- D. Where conductors enter a raceway, cabinet, pull box, and junction box, the conductors shall be protected by an insulated bushing providing a smoothly rounded surface.
- E. Double lock nuts shall be used at termination of rigid conduit in knock-out openings.
- F. Ends of conduits shall be equipped with insulating bushings for 1" and smaller, and insulated metallic bushings for 1-1/4" and larger. Ends of conduit shall be temporarily capped prior to installation and during construction to exclude foreign material.

3.6. FLEXIBLE CONNECTIONS

- A. Provide Flexible Metal Conduit (FMC), e.g. Greenfield, in short lengths (maximum 6 feet) for the final connection of lighting fixtures, dry type transformers and vibrating equipment in dry interior locations. The flexible connections to recessed fixtures and equipment shall be sufficient slack to permit removal of the same.
- B. Provide Liquidtight Flexible Metal Conduit (LFMC), e.g. Sealtite, in short lengths (maximum 6 feet) for the final connection of exterior equipment, motors and equipment in damp or wet locations as defined in Division 26 Section "Common Work Results for

Electrical”.

- C. Grounding conductors with green colored insulation shall be extended through all flexible connections including fixture "whips", and fastened to terminals within the first junction boxes on either side of the flexible length.
- D. Flexible connections shall be sized per the Contract Drawings, or as required in accordance with Code; the more stringent requirement shall apply.

3.7. PAINTING AND FINISHES

- A. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the Architect.
- B. All exposed conduit, boxes, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.
- C. Conduit and boxes for fire alarm cabling and devices shall be red, except for finished locations, where they shall be painted to match adjacent surfaces.

3.8. PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
- B. Repair damage to galvanized finishes with zinc rich paint recommended by manufacturer.
- C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
- D. Steel conduit: Conduit that shows corrosion within the guarantee period shall be replaced.

3.9. CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
- B. After conduits and accessories have been installed, and concreting operations completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected. Where new conduits installed are connected to new conduits installed by others, the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION

SECTION 260535 - MISCELLANEOUS RACEWAY SYSTEMS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and General Provisions of the contract, including general and Supplementary Conditions and Division 01 Specifications apply to this Section.

1.2. SUMMARY

- A. This section includes requirements for miscellaneous raceway systems for the following:
 - 1. Communications (data/voice) systems.
 - 2. Audio/Video systems.
 - 3. Security system.
 - 4. Access Control System.
 - 5. Video Surveillance System.

1.3. SCOPE OF WORK

- A. Provide conduit and boxes to form empty raceway systems.
- B. Equipment and wiring will be installed under separate contract by Owner's Special System Contractors and Division 28 unless otherwise indicated on the Contract Drawings or in another Section of these Specifications.

PART 2. PRODUCTS

2.1. CONDUIT

- A. Minimum size 1" unless noted otherwise. Refer to Division 26 Section "Raceways and Boxes" for product requirements.

2.2. OUTLET BOXES

- A. General Requirements
 - 1. Provide single or multiple gang boxes as shown on the Contract Drawings.
 - 2. Outlet boxes shall be listed to UL Standard 514A, Metallic Outlet Boxes.
 - 3. Refer to Division 26 Section "Raceways and Boxes" for general product requirements.
- B. Two-Gang Outlet Boxes for Masonry Walls
 - 1. Description: Large capacity, two-gang, 4" deep outlet boxes with plaster/tile rings

as required to suit device quantities and types. Boxes shall have welded corners and device ears inside the box to prevent mortar from getting in the device holes. Boxes shall accept standard device and flat covers. Boxes shall have a ground screw in each gang. Provide supports to secure outlet boxes to concrete block to prevent movement during construction.

2. Dimensions: 4-1/4"H x 4"W x 4"D.
3. Capacity: 54 cubic inches.
4. Knockouts:
 - a. Top: (2) 1/2", (2) 1/2"-3/4" tangential knockouts
 - b. Bottom: (1) 1" - 1-1/4" - 1-1/2" - 2" concentric knockouts
 - c. Back: (2) 1/2"-3/4" tangential knockouts
5. Provide Hubbell Catalog No. HBL985, or approved equal by listed manufacturer.

C. Two-Gang Outlet Boxes for Metal Stud and GWB Walls

1. Description: Large capacity, two-gang outlet boxes with plaster/tile rings as required to suit device quantities and types. Boxes shall provide ample space for Category 6/6A and optical fiber cable bends. Boxes shall accept standard 4-11/16" mud rings.
2. Dimensions: 4-11/16"H x 4-11/16"W x 3-1/4"D
3. Capacity: 66.7 cubic inches.
4. Knockouts
 - a. Sides: (2) 3/4"-1" tangential knockouts, (2) 1"-1-1/4" tangential knockouts, plus (2) 1"-2" concentric knockouts.
 - b. Back: (2) 3/4"-1" tangential knockouts, (2) 1/2" knockouts
5. Provide Hubbell Catalog No. HBL260, or approved equal by listed manufacturer.

2.3. PULL AND JUNCTION BOXES

- A. Refer to Division 26 Section, "Raceways and Boxes".

2.4. COVER PLATES

- A. Provide device plates to suit outlet and device type and configuration.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Provide all raceway components, as required, for complete system. Extend conduits and/or surface raceways to nearest accessible ceiling space for devices with connections within the space, and to the nearest accessible corridor ceiling space for connections/cablings back

to the IT room, unless otherwise noted on the drawings.

- B. Each run of conduit shall contain not more than two 90 degree bends and no run shall exceed 100 ft. in length. Minimum radii for bends: 10 1/2" for 1" conduit, and a minimum of ten times the trade size diameter bends for larger sizes. Do NOT use conduit fittings in lieu of bends.
- C. Provide insulating bushings on all conduit terminations.
- D. Provide pullboxes in conduit runs exceeding 100 feet (30 m) in length, and in runs with more than two right angle bends. Do NOT use conduit fittings in lieu of bends.
- E. Identify all cabinets, and pull and junction boxes as to system usage.
- F. Provide nylon pull cord in each conduit run.
- G. Provide identification tags on all conduit runs.
- H. Provide cover plates on all outlet boxes.
- I. Provide plywood backboards and duplex receptacles in equipment room(s). Confirm location on job site prior to installation. Paint all backboards with prime coat of fire resistant paint and finish coat of enamel in color to match wall. In unfinished rooms, provide gray finish coat.
- J. Coordinate all work with Owner and Owner's Special System Contractor and Division 28 Contractors.
- K. Provide underground conduit to property line for utility service entrance. Verify exact location with serving utility. Refer to Drawings and Division 26 Section, "Utility Incoming Service Provisions" for additional information.

END OF SECTION

SECTION 260543 - UNDERGROUND DUCTBANKS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
- B. Sections of other Divisions in this Specification which relate to excavation and concrete construction.

1.2. SUMMARY

- A. This Section includes complete concrete ductbank construction and direct burial materials and methods for outside power and communications systems transmission and distribution.
- B. This Section specifies underground duct placement, materials, and installation procedures

1.3. CONTRACTOR RESPONSIBILITIES

- A. All work described in this Section shall be performed and paid for under Division 26.
- B. Existing Subsurface Utilities: Existing subsurface facilities are shown on the plans to help the Contractor avoid damage to essential utilities which must remain in service. Take reasonable steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities. If the discovery of underground facilities not indicated on the plans or in a location different from what is indicated on the plans, protect such facilities, notify the Owner's representative immediately, and record actual conditions found onto the record drawings.
- C. Construction Staking:
 - 1. Provide the stakes and reference marks necessary for the construction of the improvements covered by this Contract.
 - 2. Control stakes which constitute reference points for all Construction work shall be conspicuously marked with red flagging tape. Provide responsibility to inform employees and Subcontractors of the stakes' importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be furnished at no additional cost to the Owner.

1.4. QUALITY ASSURANCE

- A. Installer: Company specializing in cast-in-place concrete structures with a minimum of three years documented experience.
 - 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.
- B. Materials: All materials shall be new and the best of their respective kinds, free from all

defects and as specified on the plans and the specifications or as accepted by the Project Engineer. Furnish materials or manufactured articles of the best grade in quality and workmanship obtainable on the market from firms of established good reputation, or if not ordinarily carried in stock, shall conform to the usual standards of first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. In general, the work performed shall be in conformity and harmony with the intent to secure the best standard of Construction and equipment of the work as a whole or in part.

- C. **Manufacturer's Recommendations:** Whether specifically mentioned or not in these Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item.
- D. **Codes and Standards:** Provide underground ductbanks conforming to the following:
 - 1. **National Electrical Manufacturers Association (NEMA) - Conform to the manufacturing standards of the following:**
 - a. RNI: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - b. TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - c. TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - d. TC 6: PVC and BAS Plastic Utilities Duct for Underground Installation.
 - e. TC 7: Smooth-Wall Coilable Polyethylene Electrical Plastic Duct.
 - f. TC 8: Extra-Strength PVC Plastic Utilities duct for Underground Installation.
 - g. TC 9: Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
 - 2. **Underwriters Laboratories, Inc. (UL): Conform to the following:**
 - a. 6: Rigid Metal Conduit.
 - b. 651: Schedule 40 and 80 Rigid PVC Conduit.
 - c. 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit.
 - 3. **American Concrete Institute (ACI):**
 - a. 318: Building Code Requirements for Reinforced Concrete.
 - 4. **American Society for Testing & Materials (ASTM)**
 - a. F512: Smooth-Wall PVC Conduit & Fittings for Underground Installation.
- E. **Certification:** Manufacturer shall be a company specializing in ductbank structures with a minimum five years documented experience.

1.5. SUBMITTALS

- A. Submit shop drawings and product data for all conduit, duct, ductbank materials, accessories, and miscellaneous components. Submit product data for each type of

manufactured material and product indicated.

- B. Indicate material specifications, dimensions, capacities, and reinforcing details. Submit concrete product data, concrete mix design, and certified mill test reports for steel bars.
- C. Submit coordination shop drawings of ductbank and underground cable installations including profiles and elevations of all utility crossings. Proposed deviations from details on the Drawings shall be clearly marked on all Submittals.
- D. Record Documents: Show dimensional locations of underground ducts and handholes.

1.6. SITE CONDITIONS

- A. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.
- B. Traffic Access:
 - 1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.
 - 2. Provide responsibility for coordinating and obtaining approvals of the location for temporary barricades and/or detours of traffic from the Police and Fire Departments.
 - 3. If peripheral fencing is used, it shall be provided with reflectors, flashers, signs, danglers, or barricades as the fence is being built.
 - 4. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.
 - 5. If traffic is reduced to one way, provide a flag person. A minimum of one lane shall be maintained open to traffic at all times.
 - 6. When entering or leaving road ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.
 - 7. Supply and maintain cone placements at his sole additional expense.
 - 8. All traffic signs which fall within the line of Construction or are obstructed by the equipment or operations shall be temporarily relocated to an unobstructed area. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work, include, but are not limited to, the following:

1. Conduit and Fittings:
 - a. Carlon Electrical Products.
 - b. George-Ingraham Corporation.
 - c. Condux International.
2. Ductbank Accessories:
 - a. Carlon.
 - b. Osburn Associates.
 - c. Underground Devices, Inc.
 - d. OZ/Gedney

2.2. UNDERGROUND DUCTBANKS

A. General: Underground ductbanks to be arrangements of single bore, PVC plastic conduits concrete encased. The number and size of conduits to be as indicated. Turn up connections through slabs or floors shall be rigid metal.

B. Material:

1. Conduit and Fittings:
 - a. Type II, heavy wall Schedule 40 PVC plastic, sunlight UV-resistant, in accordance with the requirements of NEMA publications TC-2 and TC-3 (fittings).
 - b. Rigid galvanized heavy wall steel conduit (UL 6) with threaded couplings.
 - c. Rigid Metal Conduit, PVC Coated, UL 6, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal 40 mils thick, conforming to NEMA RN 1, Type A40.
 - d. Conduit and fittings shall have a temperature rating at least equal to the operating temperature of the cable which it contains, minimum 90 degrees C. Conduit and fittings shall be free from all substances that injuriously affect any wire or cable insulation.
 - e. The Manufacturer shall certify that the plastic is 100 percent virgin material and the finished product meets the specifications. All PVC conduit and fittings shall have solvent-weld connections and shall provide a water-tight joint.

C. Conduit

1. Size as indicated on the Drawings. If conduit sizes are not indicated on the Drawings, then the conduits shall be sized as follows:
 - a. Four inches nominal for 600 volts or lower and for Communication
 - b. Five inches nominal for voltages above 600 volts.

- D. Elbows: rigid heavy wall galvanized steel with a minimum bend radius of 36 inches (915 mm).
- E. Conduit Termination in Utility Holes and Buildings
 - 1. End Bells: Manufactured end bells of appropriate sizes at each end of conduit. When entering a new building or a new manhole, the end bells for PVC shall be a pre-manufactured system (as manufactured by Formex, or equal) with conduit seals, provision for roughing into the concrete, and water stops.
 - 2. Bushings: Pre-manufactured groundable steel bushings of appropriate sizes where bell ends are not used. Steel bushings shall be used on all metal conduit. When entering a new building, or a new manhole, the bell ends for PVC shall be a pre-manufactured system (System as manufactured by Formex or equal) with conduit seals, provisions for roughing into the concrete pour and water stops.
 - 3. Seals: When entering, below grade, an existing building or manhole, the concrete shall be core-drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.
 - 4. Fire Stopping/Sealant: All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam Conduit Sealant manufactured by 3M Fire Protection Products, or approved equal.
- F. Plugs: Closure plugs or caps of the same material as the conduit at the ends of the unused sections at manholes, and at building entrance openings.
- G. Pull wire: Provide a polypropylene, twisted yellow, rot and mildew-resistant 3/8" minimum pull rope (2400 lbs. tensile strength) in each empty duct.
- H. Grounding: Rigid steel conduit with end bells shall be provided with an Appleton Catalog No. XJB Series or equal ground bushing with bonding strap. Connect bonding strap to ground wire in electrical distribution equipment, e.g. transformer(s).
- I. Drainage Assembly: All ducts shall drain to an open end away from the building or electrical equipment. Ducts shall drain towards handholes wherever possible.

2.3. ACCESSORIES

- A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting. Spacers shall be interlocked horizontally only. Provide nylon tie-downs to hold ducts to spacers. Concrete blocks are prohibited for duct spacers.
- B. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, including adapter for connection to conduit.
- C. Underground Line Warning Tapes:

1. Refer to Division 26 Section, "Electrical Identification" for product requirements.
2. Bury underground line warning tape 12-inches below grade above every ductbank and buried conduit.

2.4. TEST PITS

- A. Provide test pits to locate all utilities and structures. Provide test pits as necessary to determine actual locations and profiles of obstructions to proposed new work.
- B. Verify existing utilities, locations, and inverts and points of connection.

2.5. PAINTING

- A. General: All exposed conduit shall be primed and painted to match existing building exteriors.
- B. First coat: Zinc Duct - Zinc oxide primer house and trim paint.
- C. Second Coat: Type and color to match existing building walls and/or trim where applicable.

PART 3. EXECUTION

3.1. LOCATION AND LAYOUT

- A. Indicated plans and profiles: Approximate, based on field information and available as-built plans.
- B. Actual locations and profiles: Based on test pits to locate all shown utilities and structures. Test pits at beginning, center, end, and at all ductbank bends and utility crossings.
- C. Plan and profile adjustments: All provided at no additional cost to Owner, subject to approval.
- D. Examine site to receive underground ductbanks for compliance with installation tolerances and other conditions affecting performance of the underground ductbanks. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. In accordance with NEMA publication TC-2 and manufacturer's recommendations.
- B. Top of envelope below grade: Minimum as indicated on the Drawings.
- C. Seal and Thru Wall Fittings: At entrances to buildings for watertight construction.
- D. Sweeps and bends: Minimum 25 foot radius (except at conduit risers) unless otherwise approved to accomplish changes in direction of runs either horizontally or vertically. Double offsets: Minimum 100 foot radius. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.

- E. Mandrel conduits: Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.
- F. Clean conduits: After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.
- G. Pull Line: Provide 100-pound-tested nylon pull line in all conduits, including spares. Provide 3 feet of slack at each end of conduit and tag.
- H. Stagger vertical conduit joints: Minimum 6 inches. All joints shall have couplings installed.
- I. Reinforcing steel: Provide reinforcing steel the entire length of the duct system. Provide four #4 bars, one in each corner minimum, overlap the joints 12-inches, and tie them into the respective utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of any duct.

3.3. EXCAVATION, BACKFILLING, COMPACTING AND SITE PREPARATION

- A. Provide all excavating and backfilling and site preparation necessary to install underground ductbanks, cables, etc., included in this section of the work. Excavation and backfill shall be performed in accordance with the requirements of Division 26 Section, "Common Work Results for Electrical".
- B. Install forms on sides of the ductbank if the trench is not of the proper firmness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, and backfilling.
- C. The bottom of the trench shall be undisturbed earth. If the trench bottom is too low for proper grade, fill to the proper level with sand and mechanically compact it. Cut trenches neatly and uniformly.
- D. Each excavated section between utility holes and from utility holes to the building shall be completely excavated and graded before any duct is laid in that section.
- E. Provide underground line warning tape 12-inches below finished grade over all ductbanks. Refer to Division 26 Section "Electrical Identification" for product requirements.
- F. Excavation and Backfill: Refer to Division 26 Section "Common Work Results for Electrical".
- G. After excavation of the trench, stakes shall be driven in the bottom of the trench at four-foot intervals to establish the grade and route of the duct bank.
- H. Pitch the trenches uniformly towards utility holes or both ways from high points between utility holes for the required duct line drainage. Avoid pitching ducts towards buildings wherever possible.
- I. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.

- J. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.
- K. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching..
- L. Restore disturbed paving.
- M. Remove pavements, sidewalks, curbs, and gutters where necessitated by construction of ducts.
- N. On completion of distribution systems construction, replace pavements, sidewalks, curbs and gutters.
- O. Surplus earth from the trenches, after compacting, shall be removed and disposed of.

3.4. CUTTING AND PATCHING

- A. Provide all cutting and patching necessary for the installation of the electrical work. Any damage done to the work already in place by reason of this work shall be repaired expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.
- B. Existing Obstructions: Where drawings indicate that underground conduits are to cross under existing roadways, walks or other similar paved areas, steel conduits shall be driven under such areas in lieu of installing the conduits in trenches as specified above. After installation of conduit by either method, all existing paved or grass areas which have been disturbed in any way shall be restored to their original conditions.
- C. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

3.5. PLACEMENT OF CONDUIT

- A. Install spacers as recommended by the conduit manufacturer and requirements stated above, but not to exceed a maximum of four feet on center for PVC conduit and eight feet on center for steel conduit. Bottom spacers shall rest on 8-inch x 16-inch x 2-inch minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 inches minimum horizontally.
 - 1. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked conduit assembly.
 - 2. Before placing concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete placement. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.

3. Set on masonry leveling blocks prior to pour.
- B. Pitch conduit properly for drainage to handholes and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.
- C. Provide accurate locations of conduit in utility hole.
- D. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 1-1/2-inches on all sides.
- E. Lay conduits using spacers to provide tier spacing.
- F. Make tight conduit joints by complying with recommendations of conduit manufacturer, using coupling jointing compound or PVC primer and solvent cement. All joints in conduits and fittings shall be made up tight and shall be watertight. All threaded portions of steel conduits that are not to be encased in concrete and adjoining ends of conduits, couplings and fittings, shall be heavily coated with asphaltum after installation. All connections between conduits of different types shall be made in an approved manner, using adapters of other materials and methods recommended for the purpose by the conduit manufacturers.
- G. Provide not more than one 90-degree bend or equivalent between pull points for primary conduit and two 90-degree bends or equivalent for signal conduit.
- H. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct. Any offsets or bends shall be made in steel conduit. PVC conduit may only be used in straight lengths.
- I. Provide end bells on ducts at hand holes.
- J. Provide insulated, grounding bushings on duct ends in equipment enclosure.
- K. Plug or cap empty conduits. Provide standard manufactured plugs.
- L. Seal all ducts and conduits, at both ends with foam duct sealant to prevent the entrance of moisture and gases. Refer to Division 26 Section "Common Work Results for Electrical" for product requirements.
- M. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.
- N. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.
- O. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.
- P. Conduit Couplings: Conduit couplings shall be staggered so that couplings on adjacent conduits will not lie in the same transverse plane. End bells shall be spaced approximately 9 inches center to center at face of manhole wall for 4-inch conduits and proportionately

spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10 feet from the face of the manhole wall and shall be made in such a way that the slope of any conduit will not be less than that of the main bank and no trap will be formed. New conduit entrances into existing manholes and building walls shall enter at the most desirable locations consistent with grading requirements and existing entrance and shall be waterproofed in a satisfactory manner.

- Q. Bends: Conduit generally shall be straight between manholes or upturned elbows. Where bends are unavoidable in non-metallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100 feet. For radii less than 100 feet, 5-degree angle couplings or 5-degree factory-made bend sections shall be used.
- R. Install top of duct bank minimum 30 inches below finished grade.
- S. Multiple conduit: Install multiple conduit as follows:
 - 1. Multiple conduit runs, direct burial or in duct bank, shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following:
 - a. Two (2) inches between conduits containing cables operating at not over 600 volts.
 - b. Two (2) inches between conduits containing cables operating at over 600 volts.
 - c. Two (2) inches between telecommunications conduits.
 - d. Six (6) inches between a telecommunications conduit and any power conduit in the same envelope.
 - e. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couplings and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10-inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.
 - 2. Multiple conduit runs shall be arranged substantially as shown on the drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, the condition shall be referred for instructions before further work is done. All underground conduit work shall be coordinated with other outside service work. Existing outside services shall be maintained in operation unless directed otherwise.

3.6. CONDUIT AND DUCT INSTALLATION

- A. Install nonmetallic conduit and duct as indicated according to Manufacturer's written instructions.
- B. Slope: Pitch ducts a minimum of 4 inches per 100 feet (1:300) to drain toward manholes

and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions. Trenches shall be evenly graded so that conduits will have a uniform rate of fall of not less than 3 inches per 100 feet and will be free from either horizontal or vertical waves. Unless otherwise specified, each conduit shall slope uniformly from one manhole to the next or from a high point between manholes. Low points between manholes or between upturned elbows, shall be avoided wherever possible. Where it is not possible to avoid a trap or low point in a conduit which has no concrete envelope, provide a 1/2-inch hole drilled in the bottom of the conduit at the low point and a crushed stone sump of suitable volume below the conduit. If possible, install the sump above the high water table elevation for the particular location. Otherwise, provide special means to prevent the accumulation of water within the conduit.

- C. Curves and Bends: Use manufactured elbows with a minimum radius of 36 inches for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet both horizontally and vertically at other locations.
- D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Installation of warning tapes: After placing a minimum of 12 –inches or a maximum of 18 inches of backfill over the ducts, place the appropriate warning tapes above and parallel to the centerline of the duct for the entire length of the duct trench.
- F. Provide pull rope and measuring tape at the time a mandrel is pulled through each conduit. Record the wall-to-wall measurements and the size of mandrel used at this time. Provide this documentation to the Project Engineer on the following working day. After acceptance of these documents, the Contractor shall remove the measuring tape, leaving only the pull rope in the conduits.
- G. All work and materials covered by these Specifications shall be subject to inspection at times by the Owner's designated representative. Any work concealed before it has been inspected by the Owner's designated representative shall be re-opened or uncovered and any required modification made to that portion of the work. All trenches shall be opened from manhole to manhole or manhole to building prior to laying conduit in that trench. Exceptions (such as street crossings) will be approved prior to excavation on a case-by-case basis by the Owner at a regular project meeting. These sites shall be inspected by the Owner's representative during excavation, installation, backfill, restoration, and cleanup.
- H. Separation distance from other buried utilities as follows:
 - 1. All others: 18-inches.

3.7. REUSE OF EXISTING DUCTBANKS

- A. Where new cables are to be installed in existing ductbanks and conduit, mandrel and brush clean each duct prior to installation of new cable. Mandrel and brush procedures shall be as specified for new conduit and ductbanks. If any duct is found to be collapsed, or deformed, it shall be brought to the attention of the Engineer immediately.

3.8. DIRECT BURIED CONDUIT

- A. Provide where indicated direct-buried electrical circuits utilizing PVC Schedule 40 conduit, as indicated. Conduit shall be as specified in Division 26 Section, "Raceways and Boxes". Burial depth shall be as follows:
 - 1. Below paved roads (PVC and RGS): 30-inches below bottom of paving.
 - 2. Under non-vehicle concrete (PVC and RGS): 24-inches below bottom of paving.
 - 3. Other areas (PVC): 24-inches.
 - 4. Other areas (RGS): 24-inches.
- B. Minimum separation from other utilities shall be the same as for ductbanks, specified previously in this Section.
- C. Where feasible, and where indicated, install direct-buried lines parallel, but separated from other utility lines. Group several direct-buried conduits in a common trench where running in the same direction, or to/from the same source. All direct-buried conduits shall have yellow plastic warning tape buried midway between the conduit and finished grade. Tape shall be the same as used for ductbanks.
- D. Where direct-buried conduits penetrate walls or floor slabs, seal all spaces around conduit and fittings. Provide through-wall fittings on all wall penetrations.
- E. Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor, provide a sleeve made of Schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with a suitable plastic expansible compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device hereinbefore specified will be acceptable in lieu of the sleeve.

3.9. RECORD DOCUMENTS

- A. Provide record set data of the actual elevation of the top of each end of each raceway or ductbank at the midpoint, at no more than 100 foot intervals, where changes in elevation are less than 2 feet between data points, or 10 foot intervals when the elevation between intervals is different by 2 feet or more between data points.
- B. Provide record drawings indicating actual locations of all installed ductbanks and handholes including elevations. The record drawing shall indicate location, elevation, and type of service for all utilities crossed by new ductbank.
- C. Cable Records: The Contractor shall provide a complete listing of all cables installed in each conduit and ductbank, along with all cable splice locations.

3.10. FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Division 26 Section "Common Work Results for Electrical" in the presence of the Engineer.
- B. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled

through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/4-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

- C. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

END OF SECTION

SECTION 260545 – HAND HOLES

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. SCOPE

- A. Prefabricated and cast-in-place utility holes, refurbishing existing utility holes and utility hole accessories.
- B. Complete construction and outfitting of all new handholes, and in-ground junction boxes.
- C. Provide all labor, materials, equipment, and services necessary to provide and handholes as indicated.

1.3. RELATED WORK

- A. Related Sections include the following:
 - 1. Division 26 Section “Common Work Results” for excavation and backfill requirements.
 - 2. Division 26 Section “Conductors and Cables” for conductors installed in raceways and boxes and conductor terminations.
 - 3. Division 26 Section “Underground Ductbanks” for direct-buried conduits and underground ductbanks terminating at utility holes.

1.4. QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete or cast-in-place utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a minimum of a 3-year record of successful in-service performance.
- B. Comply with NFPA 70: National Electrical Code and ANSI C2 National Electrical Safety Code for components and installation.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications; A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- D. Coordinate layout and installation of conduits and handholes with final arrangement of other utilities as determined in the field.

- E. Coordinate elevations of conduit and ductbank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to handholes, and as approved by the Engineer.
- F. The following Codes, Regulations, Reference Standards and Specifications apply to work included in this Section:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. Codes and Standards, Section 01060:
 - a. AASHTO Standards: M199 - Precast Reinforced Concrete Utility Hole.
 - b. ANSI: C80.1.
 - c. ASTM: A36, A48, A153, A386, A615, C33, F512.
 - d. Federal Specifications:
 - i. TT-P-0035.
 - ii. RR-F-621E Frames, Covers, Gratings, Steps, Sumps, and Catch Basin Utility Hole.
 - iii. SS-S-210A, Sealing Compound, Pre-formed Plastic for Expansion Joints and Pipe Joints.
 - e. National Electrical Code, NFPA-70.
 - f. American Concrete Institute (ACI):
 - i. 318 - Building Code Requirements for Reinforced Concrete.

1.5. SUBMITTALS

- A. Submit shop drawings and product data under provisions of General Conditions of the Contract and Division 26.
- B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
- C. Provide product data for handholes and accessories.
- D. Submit manufacturer's installation instructions under provisions of General Conditions of the Contract.
- E. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.
- F. Inspection report for factory inspections, according to ASTM C 1037.
- G. Field test reports indicating and interpreting test results relative to compliance with performance requirements of Field Quality Control Article in Part 3 of this Section.
- H. Submit Shop Drawings, including the following:
 - 1. Drawings for each size and configuration of precast handhole with details of accessories and joints.

2. Drawings depicting size, shape, configuration and identification of all cover plates and their legends.

1.6. PROJECT RECORD DOCUMENTS

- A. Submit under provisions Division 26 Section, "Common Work Results for Electrical".
- B. Accurately record actual locations and depths of each handhole. Indicate location, elevations, type of service, quantity and depth of all ductbank connections.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Division 26 Section, "Common Work Results for Electrical".
- B. Accept products on site. Inspect for damage.
- C. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- D. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- E. Lift and support precast concrete units only at designated lifting or supporting points.

1.8. COORDINATION

- A. Obtain all available information on underground utilities before starting excavation. If underground utilities interfere with shown location of handholes, bring this to the attention of the Engineer as soon as possible. The utility hole shall be revised or relocated only with the approval of the Engineer.
- B. Coordinate exact location of each handhole centerline based on local grade, new and existing utilities, and other items which may affect placement.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work include, but are not limited to, the following:
 1. Precast Polymer Handholes and Pullboxes:
 - a. Hubbell Quazite
 - b. Jensen Precast
 - c. Oldcastle

2.2. PRECAST POLYMER HANDHOLES AND PULL BOXES

- A. Description: Precast polymer concrete enclosures for use as hand holes, pull boxes, splice

boxes or equipment enclosures for underground utility services.

B. Construction:

1. Polymer concrete shall be made from selectively-graded aggregates in combination with a polymer resin, and shall be reinforced with fiberglass for exceptional strength and rigidity.
2. Covers shall be heavy-duty type with gasket to reduce incoming fluids into the enclosure. Covers shall be secured to enclosures with stainless steel bolts.

C. Dimensions:

1. Enclosures shall be sized as indicated on the Contract Drawings, unless otherwise noted or required by the National Electrical Code based on size and layout of conduits terminated at the same.
2. Provide enclosures where required for long underground conduit runs, in addition to enclosures indicated on the Contract Drawings.
3. Enclosures shall be no less than 11-inches x 18-inches x 18-inches deep.

D. Covers:

1. Heavy-duty type with non-skid surface, same design load (Tier level) rating as respective enclosures.
2. Tier level ratings shall be embossed on the surface of all covers.
3. Gasket to reduce incoming fluids into the enclosure, secured to enclosures with stainless steel bolts.
4. Factory embossed with lettering (minimum 1/2" high text) to identify system served by enclosure, as follows:
 - a. Power, 600V or Less: Electric
 - b. Power, above 600V: High Voltage
 - c. Lighting: Lighting
 - d. Telecommunications: Communications
 - e. Telephone: Telephone
 - f. Cable Television: C.A.T.V.
 - g. Optical Fiber: Fiber Optics

E. Installation: Enclosures shall sit flush with finished grade elevation. Provide a minimum of 6-inch layer of compacted gravel for drainage, with filter cloth between handhole and gravel layer.

F. Quality Assurance:

1. Enclosures and covers shall conform to all test provisions of the most current ANSI/SCTE 77 "Specification for Underground Enclosure Integrity" for Tier 15 (minimum) applications and shall be UL listed. Refer to Contract Drawings for

Tier Ratings of individual handholes.

2. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met shall be included with product submittal.

G. Basis of Design: Quazite PG style enclosures, as manufactured by Hubbell.

PART 3. EXECUTION

3.1. EXCAVATION

- A. Provide responsibility for all demolition, excavation and backfilling required to install hand holes.
- B. After completion of utility hole installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, etc.

3.2. INSTALLATION – HANDHOLES AND PULLBOXES

- A. Install and seal precast sections in accordance with manufacturer's instructions.
- B. Use gasketed precast neck and shaft sections to bring utility hole entrance to proper elevation.
- C. Install utility holes plumb.
- D. Set the top of each utility hole to finished grade elevation.
- E. Provide where indicated and where required for long underground wire runs. Larger dimensions may be required per NEC for cables involved.
- F. Handholes shall be set level and adjusted for the final grade. Conduit penetrations shall be sealed with grout or waterproof sealant. All conduit ends shall have nylon or plastic bushings to prevent damage to insulation when pulling.
- G. All wiring within handholes, whether spliced or not, shall be identified with permanently indented or engraved tags as to circuit origination, circuit #, and load served.

3.3. UNDERGROUND UTILITY STRUCTURE INSTALLATION

- A. Elevation: Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1-inch (25 mm) above grade.
- B. Precast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C 891.
 1. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

2. Support units on a level bed of crushed stone or gravel, graded from the 1-inch (25 mm) sieve to the No. 4 sieve and compacted to the same density as the adjacent undisturbed earth.

3.4. GRADE ADJUSTMENTS TO SURFACE STRUCTURES

A. Frames and Covers:

1. Frames and covers of all utility holes shall be adjusted to proposed finish grade. Grade rings shall be supplied and installed as required.
2. Frames of new or adjusted surface structures shall be supported by concrete with minimum dimensions as follows: Sixty inches wide by ten inches deep (60-inches W x 10-inches D).

B. Structures Within Paved Areas:

1. A structure located in an area resurfaced with asphalt concrete shall not be constructed to final grade until the adjacent pavement or surfacing has been compacted.
2. Provide responsibility for referencing structures prior to paving and locating them after paving operations are complete.
3. After asphalt concrete resurfacing is complete, the asphalt shall be cut out six inches (6-inch) wider than the frames of all surface structures. Each frame shall then be raised to finished grade and supported by concrete as noted above. Lamp black shall be added to the concrete to produce a dark finished surface which matches the surrounding asphalt concrete surface.

3.5. FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Duct Integrity: Rod ducts with a mandrel 1/4-inch (6 mm) smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
2. Water Tightness: Make internal inspection of handholes three (3) months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after two (2) months and reseal remaining leak sources. Repeat process at two (2) month intervals until leaks are corrected.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.6. CLEANING:

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch

(12 mm) greater than internal diameter of duct.

- B. Clean internal surfaces of handholes. Remove foreign material.
- C. All necessary precautions to avoid the flooding of utility holes and conduits. If the utility holes or conduits should become flooded or littered with debris any time prior to final acceptance, pump dry and clean utility holes and ducts to the satisfaction of the Engineer.
- D. Clean-Up: Remove debris from handholes and ensure complete installation is left in neat and finished condition.

END OF SECTION

SECTION 260553 - ELECTRICAL IDENTIFICATION

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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.
- B. This section includes labeling of all terminations and related subsystems; including, but not limited to, nameplates, wire and cable markers, labeling and identification of cables, equipment and other products.

1.3. SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4. QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.
- D. Comply with applicable EIA/TIA Standards.
- E. Comply with OSHA Standards.

1.5. DEFINITIONS

- A. Emergency systems include, but are not limited to, fire alarm systems, exit sign circuits, emergency lighting circuits, etc.

PART 2. PRODUCTS

2.1. RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service as well as circuit designation for all feeders.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend, overlaminated with a clear, weather- and chemical-resistant coating.

- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 3/4 inch wide, in appropriate colors for system voltage and phase.
- E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2. WIRING DEVICE FACEPLATE LABELS

A. Adhesive Labels:

- 1. Thermal transfer printable, clear polyester material with glossy finish, 1/2" high, width as required. Printed lettering shall be 1/4" high black text.
- 2. Faceplates for line-voltage shut-off switches for gas-fired equipment shall be labeled to read "Gas Burner Emergency Switch, On, Off". Faceplates shall be red with white lettering.
- 3. Labels shall be backed with permanent acrylic adhesive and shall exhibit good adhesion to many metal and other types of surfaces, including textured surfaces and low surface energy plastics.
- 4. Labels shall be resistant to humidity, temperature and UV light.
- 5. Labels shall meet requirements of UL 969 Labeling and Marking Standard and shall be RoHS compliant.
- 6. Provide Brady B-432 Series, or approved equal by acceptable manufacturer.

B. Factory Labeled Faceplates:

- 1. Faceplates for devices on GFCI-protected circuits shall be factory engraved to read "GFCI". Refer to Division 26 Section, "Wiring Devices" for additional information.

2.3. EQUIPMENT NAMEPLATES

A. General Nameplate Requirements:

- 1. Use colors prescribed by ANSI A13.1, NFPA 70 and as follows:
 - a. Normal Power System: White lettering on black background.
- 2. Backed with adhesive material formulated for the type of surface, intended use and installed location.

B. Nameplates for Dry, Interior Locations:

- 1. Engraving stock, melamine 3-layer plastic laminate.

2. Minimum 1/16-inch (1.6-mm) thick for signs up to 20 sq. inches (129 sq. cm)
 3. Minimum 1/8-inch (3.2-mm) thick for signs larger than 20 sq. inches.
- C. Nameplates for Damp/Wet Interior and Exterior Locations:
1. Weather-resistant, UV Resistant, minimum 1/8-inch (3.2-mm) thick.
- D. Refer to Contract Drawings for typical nameplate details.
- E. Refer to Paragraph "Equipment Identification Nameplates" under Part 3 of this Section for installation requirements.
- 2.4. SAFETY SIGNS
- A. Comply with 29 CFR, Chapter XVII, Part 1910.45.
- 2.5. UNDERGROUND LINE WARNING TAPE
- A. Non-biodegradable, polyethylene tape, 5 mil minimum thickness and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers, colored as follows:
1. Electrical ducts, piping or cable (600V and below) – Red tape with black printed labeling: CAUTION-BURIED ELECTRIC LINE BELOW.
 2. Telephone conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED TELEPHONE LINE BELOW.
 3. Communications Conduits or Cable – Orange tape with black printed labeling: CAUTION – BURIED COMMUNICATIONS LINE BELOW.
 4. Fiber Optic conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED FIBER OPTIC LINE BELOW.
- B. Where two (2) or more services share a common ductbank, i.e. telephone and fiber optic, warning tape for each service shall be installed above each service's respective conduit(s).
- C. Bury marker tape 12-inches below grade above every ductbank and buried conduit. Refer to Division 26 Section, "Underground Ductbanks" for additional information.
- 2.6. MISCELLANEOUS IDENTIFICATION PRODUCTS
- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength: 50 lb (22.3 kg) minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
1. Primer for Galvanized Metal: Single-component acrylic formulated for galvanized surfaces.
 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3. EXECUTION

3.1. INSTALLATION

- A. General:
1. Where mixed voltages are used in one building (e.g., 480 volts, 208 volts), each piece of equipment, including but not limited to, panelboard(s), transformer(s), safety switches, outlet/pull/junction boxes, etc., on each system must be labeled for voltage in addition to other requirements listed herein.
 2. All branch circuit panelboards must be identified with the same designation used in the circuit directory in the Main Distribution Panelboard and in Distribution Panelboards.
 3. Before attaching labels, clean all surfaces with the label manufacturer's recommended cleaning agent.
 4. Install all labels firmly, as recommended by the label manufacturer.
 5. Labels attached to wiring device faceplates and electrical equipment shall be installed plumb and neatly on all equipment.
 6. Install nameplates parallel to equipment lines.
 7. Secure nameplates to equipment fronts unless otherwise noted.
 8. Secure nameplate to inside of recessed panelboards in finished locations.
 9. Embossed tape will not be permitted for any application.
 10. Stenciling is prohibited.
 11. Labels: All labels shall be permanent and be machine-generated. **NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.**
 12. Label size shall be appropriate for the conductor/cable size(s), and wiring device faceplate layout. All labels to be used shall be self-laminating, white/transparent

vinyl and be wrapped around the cable. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

B. Panelboard Circuit Directories:

1. Panelboards shall be equipped with equipment nameplates as specified in paragraph "Equipment Identifications Labels" in this Section.
2. Panelboards shall have accurate typed circuit directories indicating exactly what each branch circuit serves.
3. The Contractor shall provide up to date circuit directories in new panelboards, , and to note the date of all changes on the directory.
4. The circuit directories shall reflect the actual room numbers. Directories indicating the reference room numbers on the contract drawings or in the panelboard schedule shall not be acceptable.
5. The circuit directories shall include the name, address, and contact information for the Electrical/Division 26 Contractor.
6. If at anytime after occupancy the circuit directories are found to be incorrect due to negligence by the installer, then the Contractor shall trace out circuits, and correct the directories at no additional cost to the Owner.

C. Miscellaneous Identification:

1. Individual circuit breakers, in distribution panelboards: 1/4-inch text (6 mm); identify circuit and load served, including location.
2. Individual circuit breakers, enclosed switches, and motor starters: 1/4-inch text (6 mm); identify load served, circuit and voltage.
3. Junction boxes: 1/4-inch text (13 mm); identify load served, circuit and voltage.

D. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

F. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

G. Self-Adhesive Identification Products: Clean surfaces before applying.

H. Color Code Banding and Painting of Raceways, Boxes, and Cables.

1. Color coding of conduit and boxes shall not apply in finished spaces. In finished

- spaces, paint exposed boxes and conduits to match adjacent surfaces, unless otherwise directed by Architect.
2. Band all exposed and concealed accessible raceways, pull boxes, and junction boxes of the systems listed below:
 - a. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - b. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 - c. Junction boxes, pull boxes, and their covers shall be distinctively painted to identify their service.
 - d. Apply the following colors to the systems listed below:
 - i. Fire Alarm System: Red.
 - I. Caution Labels for Boxes and Enclosures: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover. Install label on inside face of door or cover in finished spaces.
 - J. Circuit Identification Labels on Boxes: Install labels externally.
 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 2. Concealed Boxes: Plasticized card-stock tags.
 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
 - K. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line warning tape located directly above line at 12 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
 - L. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system. Refer to Division 26 Section "Conductors and Cables" for additional requirements.
 - M. Power-Circuit and Control Wire Identification: Metal tags or aluminum, wraparound marker bands for each conductor, cables, feeders, and power circuits in vaults, panelboard gutters, outlet boxes, junction boxes, pullboxes, switchboard rooms, and at load connections. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.
 1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- N. Apply identification to conductors as follows:
1. Conductors to be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- O. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- P. Equipment Nameplates
1. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification.
 2. Install on each piece of equipment provided with factory installed disconnecting means, e.g. ERV units, where a separate external disconnecting means is not provided under Division 26.
 3. Install on each variable frequency drive serving pumps, fans, etc. provided by others where a separate motor controller is not provided under Division 26.
 4. Unless otherwise noted, nameplates shall identify equipment designation(s), voltage rating, and source (including source locations).
 5. Nameplates for disconnect switches, motor starters, etc..., shall indicate the designation of the load served as the "equipment designation".
 6. In general, nameplates requiring one or two lines of text shall be 1-1/2 inches high. Labels requiring three lines of text shall be 2 inches high. The first line of text, which shall indicate equipment designation/load served, shall utilize ½ inch high lettering. Remaining lines of text, which shall indicate voltage ratings and source information shall utilize ¼ inch high lettering. Refer to the Drawings for nameplate examples.
 7. Apply nameplates to each unit of the following categories of equipment:

- a. Panelboards.
- b. Transformers.
- c. Disconnect Switches.
- d. Enclosed Circuit Breakers.
- e. Motor Controllers.
- f. Push-Button Stations.
- g. Electrical Cabinets and Enclosures.
- h. Lighting Control Devices. (Control Panels, etc.)
- i. Fire Alarm Control Panel.
- j. Access Control and Intrusion Detection System Control Panels.
- k. Access Doors and Panels for Concealed Electrical Items.

Q. Conduits Containing Electrical Feeders:

- 1. All conduits containing electrical feeders shall be identified with W.H. Brady B-500 vinyl cloth pipe markers or equivalent. Systems shall be identified as follows:
 - a. Labels shall be applied whenever a conduit enters or leaves a switchboard, panelboard, or a junction or pull box, and at each side of penetrations of walls or floors.
 - b. Apply Y-35 series individual numbers and letters to indicate feeder circuit designation followed by feeder voltage.
 - c. At each end of the above series of markers provide a pipe banding tape around the conduit. Refer to paragraph "Color Code Banding and Painting of Raceways, Boxes, and Cables" in part 3 of this Section for banding requirements.

R. Communication Conduit and Cables:

- 1. Cables shall be identified with Brady B-500 vinyl cloth markers or equivalent by L.E.M., Stranco, or Panduit wire markers.
 - a. Each cable shall be identified at each point of entrance to or exit from a conduit or enclosure and at 50-foot intervals in the tray. All identification at 50-foot intervals shall be at the same location in the tray. Each cable shall be identified at control panels, junction boxes, and terminal boards.
- 2. Conduit shall be identified with Brady Vinyl Cloth B-500 pipe markers or equivalent. Systems shall be identified as follows:
 - a. Conduit shall be identified exiting an enclosure or panel at junction or pull boxes, and at each side of penetrations of walls, partitions, or floors, within 1-foot of penetration, to identify service type, i.e. "TELEPHONE", "DATA", "CATV", etc...

S. Fire Alarm: Junction box covers shall be painted red, except in finished spaces where they shall be painted to match adjacent surfaces. Box covers shall have a type written label to read "Fire Alarm" in accordance with requirements of NFPA 72.

T. Surfaces shall be cleaned and painted, if specified, before applying markings.

- U. Place markings so that they are visible from the floor.
- V. Protect finished identification to ensure that markings are clear and legible when project is turned over to the Owner.

END OF SECTION

SECTION 260573 – ELECTRICAL SYSTEMS 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. SCOPE

- A. An Engineering Analysis and Coordination Study shall be performed on and include all portions of the electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study, time-current analysis of each protective device, and equipment evaluation study.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E – Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEEE Guide for Performing Arc-Flash Calculations.
- C. The project/report shall begin at the overcurrent protective device ahead of the new pad-mounted transformer, to the 480/277V main distribution panelboard (MDP) and continue through the 480/277V and 208/120V distribution systems to the branch panelboards, including dry-type transformers.

1.3. REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Power Circuit Breakers Rated on a Symmetrical Current Basis.
 4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- C. The National Fire Protection Association (NFPA)
1. NFPA 70 – National Electrical Code, latest edition.
 2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4. SUBMITTALS

- A. The studies shall be submitted to the 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 study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.
- B. The results of the short circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided upon request.
- C. The report shall include the following sections:
1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
 2. Short-Circuit Methodology Analysis Results and Recommendations.
 3. Short-Circuit Device Evaluation Table
 4. Protective Device Coordination Methodology Analysis Results and Recommendations.
 5. Protective Device Settings Table
 6. Time-Current Coordination Graphs and Recommendations
 7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.

8. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
 9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.
- D. Qualification data for firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Engineer and Owner, and other information specified.

1.5. QUALITY ASSURANCE

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered State of Delaware Professional Electrical Engineer skilled in performing and interpreting the power system studies. Report shall be signed and sealed by the Engineer.
- B. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- C. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.
- D. Engineering Analysis and Coordination Study shall be performed by one of the following, or an approved and qualified equal.
 1. Cable Testing Services, Inc.

505 School House Road

Kennett Square, PA 19348

Telephone: 302-369-5420

Fax: 302-369-5515

Contact: Chris Fultz
 2. AB Engineering LLC

303 Dressage Court

West Chester, PA 19382

Telephone: 610-765-1290

Fax: 610-785-1319

Contact: Alton Baum, P.E.

3. Potomac Testing, Inc.
1610 Professional Blvd, Suite A
Crofton, MD 21114
Telephone: 301-352-1930
Toll-Free: 1-800-331-2022
Contact: Paul Gill, P.E.
4. Coordinated Power Engineering, Inc.
1340-G Charwood Road
Hanover, MD 21076
Telephone: 410-694-9494
Fax: 410-694-0085
Contact: Carl E. Rager, P.E.
5. Keystone Engineering Group, Inc.
590 East Lancaster Avenue, Suite 200
Frazer, PA 19355
Telephone: 610-407-4100
Fax: 610-407-4101
Contact: Philip M. Gonski, P.E.
6. IETC
5410 Mt. Pigsah Road
York, PA 17406
Telephone: 717-252-4730
Fax: 717-252-4793
Contact: William N. Luddy, P.E.
7. Reuter Hanney

11620 Crossroads Circle

Suite D-E

Middle River, MD 21220

Telephone: 410-344-0300

Fax: 410-335-4389

8. Schneider Electric

9 East Court, Suite G

Owings Mills, MD 21117

Telephone: 410-559-2917

Contact: Larry Long

PART 2. PRODUCTS

2.1. STUDIES

- A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.

2.2. DATA

- A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a list of required data immediately after award of the contract. 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.
- B. Source contribution may include present and future motors.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
- D. If applicable, include fault contribution of existing motors in the study. The contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3. SHORT-CIRCUIT ANALYSIS

- A. Transformer design impedances shall be used when test impedances are not available.
- B. Provide the following:

1. Calculation methods and assumptions
 2. Selected base per unit quantities.
 3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
 4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
 6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
- D. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings.
 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
 3. Contractor shall notify Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.
- 2.4. PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS
- A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
 - B. Include on each TCC graph, a complete title with descriptive device names.
 - C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - E. Plot the following characteristics on the TCC graphs, where applicable.
 1. Electric utility's overcurrent protective device

2. Medium voltage equipment overcurrent relays
 3. Medium and low voltage fuses including manufacturer's minimum emtl, total clearing, tolerance, and damage bands.
 4. Low-voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 5. Transformer full load current, magnetizing inrush current, and ANSI through fault protection curves.
 6. Medium voltage conductor damage curves.
 7. Ground fault protective devices, as applicable.
 8. Pertinent motor starting characteristics and motor damage points, where applicable.
 9. The largest feeder circuit breaker in each applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. Provide the following:
1. A one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
 2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable device, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
 4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the devices is located, and the device number corresponding to the device on the system one-line diagram
 5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
 6. Contractor shall notify Engineer in writing of any significant deficiencies in protection and /or coordination. Provide recommendations for improvements.

2.5. ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04).
- B. The flash protection boundary and the incident energy shall be calculated at all locations in the electrical distribution system (distribution panelboard, branch panelboards) where work could be performed on energized parts.
- C. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
- D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.
- F. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 5 cycles.
- H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

- J. Mis-coordination should be check amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- L. Provide the following:
 - 1. Results of the Arc-Flash Hazard Analysis shall be submitted to tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
 - 2. The Arc Flash Hazard Analysis shall report incident energy values based on recommended device setting for equipment within the scope of the study.
 - 3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.
 - 4. The Arc-Flash Hazard Analysis shall also include copies of arc-flash hazard warning labels specified in Part 3 of this Section, for all pieces of equipment receiving a label, which shall also be included in the O & M Manual specified in Division 01.

PART 3. EXECUTION

3.1. FIELD ADJUSTMENT

- A. Contractor shall adjust relay and protective device settings according to the recommended setting table provided by the coordination study.
- B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Contractor shall notify Engineer in writing of any required major equipment modifications.

3.2. ARC FLASH HAZARD LABELS

- A. Contractor shall provide a 4.0 in. x 4.0 in. (nominal) Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The labels shall be designed according to the following standards:
 - 1. UL969 – Standard for Marking and Labeling Systems
 - 2. ANSI Z535.4 – Product Safety Signs and Labels
 - 3. NFPA 70 (National Electrical Code) – Article 110.16

- C. The labels shall include the following information:
 - 1. Equipment Designation
 - 2. Source Designation
 - 3. Fault Current (kA)
 - 4. System Voltage
 - 5. Flash Protection boundary
 - 6. Personal Protective Equipment category
 - 7. Arc Flash Incident energy value (cal/cm²)
 - 8. Limited and restricted Approach Boundaries
 - 9. Study report number and issue date
 - 10. Name of Company who completed study
- D. Labels shall be printed by a thermal transfer type printer, with no field markings.
- E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
 - 1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
 - 2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
 - 3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
- F. Labels shall be field installed by Contractor.

3.3. ARC FLASH HAZARD TRAINING

- A. The vendor supplying the Arc Flash Hazard Analysis shall train the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

3.4. AVAILABLE FAULT CURRENT LABELS

- A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high

adhesion polyester for each piece of service equipment as defined in the National Electrical Code.

- B. The labels shall be designed according to the following standards:
 - 1. UL969 – Standard for Marking and Labeling Systems
 - 2. ANSI Z535.4 – Product Safety Signs and Labels
 - 3. NFPA 70 (National Electrical Code) – Article 110.24.
- C. The labels shall include the following information:
 - 1. Line 1 – “Maximum Available Fault Current”
 - 2. Line 2 – “_____ Amperes”; Contractor shall field mark maximum available fault current available at the line terminals of the equipment.
 - 3. Line 3 – Date of Installation
- D. Labels shall be printed by a thermal transfer type printer.
- E. Labels shall be field-installed by the Contractor.

END OF SECTION

SECTION 260943 - NETWORK LIGHTING 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 Specification provides the requirements for the installation, programming and configuration of a complete and operational network lighting control system. The system shall include, but not be limited to: server, software, bus supplies, network wall switches, network occupancy sensors, network day-light harvesting sensors, raceway, wire & cable and accessories required to furnish a complete and operational network lighting control system.
- B. The network lighting control system shall be a microprocessor based network system. All digital lighting system components shall be tested and cross-listed as compatible to ensure a fully functional system is setup and installed.
- C. Furnish and install a complete network lighting control system as described herein and as shown on the plans to be: wired, connected, and left in first class operating condition. Include sufficient control unit(s), wall stations, sensors, wiring, terminations, electrical boxes & cabinets and all other necessary material for a complete operating system.
- D. Related Sections:
 - 1. Section 260500 – “Common Work Results for Electrical”: Submittal requirements, general materials, installation requirements, and Record Document requirements.
 - 2. Section 262726 – “Wiring Devices”: Toggle switches, receptacles.
 - 3. Section 265100 – “Interior Lighting”: Interior lighting fixtures, and exterior building-mounted lighting fixtures.

1.3. REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - 1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - 2. ANSI C12.20 – Accuracy Standards
- B. International Organization for Standardization (ISO) (www.iso.ch):
 - 1. 9001:2000 – Quality Management Systems.
- C. National Electrical Manufacturers Association (NEMA) (www.nema.org)

1. WD1 (R2005) - General Color Requirements for Wiring Devices.
 2. WD6 – Dimensional Specifications.
- D. Underwriters Laboratories, Inc. (UL) www.ul.com:
1. 94 – Flammability Rating
 2. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 3. UL498 – Standard for Attachment Plugs and Receptacles.
 4. 508 (1999) - Standard for Industrial Control Equipment.
 5. UL514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.
 6. 916 – Energy Management Equipment.
 7. 924 (2003) - Emergency Lighting and Power Equipment
 8. 935 (2005) - Fluorescent Ballasts
 9. 1310 – Class 2 Power Units.
 10. 1472 (1996) - Solid-State Dimming Controls.

1.4. SYSTEM DESCRIPTION

- A. The Lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.
- B. The system shall be capable of turning lighting loads on/off as well as dimming lights if lighting load is capable of being dimmed.
- C. All control system devices shall be networked together enabling digital communication and shall be individually addressable.
- D. The system shall be capable of enabling stand-alone groups of devices to function in some default capacity even if network connectivity to the greater system is lost.
- E. System shall facilitate remote operation via a computer connection.

1.5. SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Specification Conformance Document: Indicate whether the submitted equipment:
 1. Meets specification exactly as stated.

2. Meets specification via an alternate means and indicate the specific methodology used.
- C. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.
- D. Shop Drawings: Provide a complete set of detailed installation drawings specific to this project that include assemblies, schedules and details as required to fully define the installation, testing, startup and other elements necessary to create a complete lighting management control system in accordance with this Specification, including:
1. Schematic (one-line diagram) of system.
 2. Large scale floor plans – Indicate location, orientation, and coverage area of each sensor, group designations, etc.
 3. Address Drawing – Reflected Ceiling Plan (RCP) indicating all static addresses for all addressable devices, including lighting fixtures, control devices, sensors, relays, network devices, etc.
 4. Wiring Diagrams and Schematics – Provide detailed wiring diagrams for each room type. Generic diagrams are not acceptable. Coordinate nomenclature and presentation with a block diagram, and differentiate between manufacturer-installed and field-installed wiring.
- E. Samples:
1. Samples showing available color and finish selections for controls shall be submitted to the Architect.
 2. Provide one sample of each field-connected device to the Division 26 Contractor for their familiarization.
- F. Certifications: Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.
- G. Sequence of Operation: To describe how each area operates and how any building wide functionality is described.
- 1.6. CLOSEOUT SUBMITTALS
- A. Start-up and Commissioning Closeout Documentation
1. Lighting Control System Manufacturer to provide enhanced start-up documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.
 2. Contractor shall submit startup/commissioning worksheets, which must be

completed prior to factory start-up.

- B. Software and Firmware Operational Documentation
 - 1. Software operating and upgrade manuals.
 - 2. Program software backup: On a compact disc complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- C. Record Documents
 - 1. Drawings showing the actual installed hardware and configuration to include: power circuits, control device identification, schedules of control functions, and static addresses for routers, ballasts/drivers, controllers, sensors, and other lighting control devices.
- D. Operation and Maintenance Data
 - 1. For lighting controls to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following Software manuals.
 - a. Adjustments of scene preset controls, fade rates and fade overrides.
 - b. Operation of adjustable zone controls.
 - c. Testing and adjusting of emergency lighting and night lighting features.
 - d. Operation manuals covering the installed lighting management system.
 - e. A complete set of Record Drawings in both hard copy (minimum 30"x42") and electronic files in .pdf and .dwg format.

1.7. QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Minimum five (5) years' experience in manufacture of network lighting control systems.
 - 2. Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
 - 3. Furnish electrical control equipment for complete installation and single source responsibility of lighting control.
 - 4. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
 - 5. Manufacturing of all sensors shall occur in the USA. Manufacturing facility must be ROHS compliant.
- B. Lighting Control System Components:

1. All applicable products must be UL / CUL Listed or other acceptable national testing organization.
2. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.
3. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.
4. All sensors and related relays shall be compatible with the specific lighting types controlled.
5. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable
6. All sensors and controlled modules connected to more than 50 VAC shall be listed by Underwriters Laboratories.
7. All sensors and related equipment shall be manufactured in the United States of America.
8. All sensors and related equipment shall have a five-year warranty.

C. Installer Qualifications:

1. Installers shall be factory-trained by the network lighting control system manufacturer.

1.8. DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Include installation, programming, and maintenance instructions.

1.9. PROJECT CONDITIONS

- A. System components shall have ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.
- B. Do not install equipment until the above conditions can be maintained in spaces to receive equipment.
- C. Do not install products under environmental conditions outside manufacturer's absolute limits.
- D. Lighting control system must be protected from dust during installation.
- E. Components shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

1.10. WARRANTY

- A. Provide manufacturer's warranty covering 5 years from date of purchase with factory startup.
 - 1. Enhanced 5-year limited parts warranty, including:
 - a. Years 1-2:
 - 1. 100 Percent Replacement Parts for Manufacturer Lighting System Components
 - 2. 100 Percent Manufacturer Labor Coverage to Troubleshoot and Diagnose a Lighting Issue
 - 3. First-Available Onsite or Remote Response Time
 - b. Years 3-5: 100% Replacement Parts Coverage

1.11. EXTRA MATERIALS

- A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user, qualified dealer or installer.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
 - 1. Occupancy/Vacancy Sensors: Quantity equal to one for every 20 of each type installed, but no fewer than one unit of each type.
 - 2. Daylight Sensors: Quantity equal to one unit for every 20 sensors installed, but no fewer than one unit.
 - 3. Power Supply Modules: Quantity equal to one unit for every 50 modules installed, but no fewer than one of each type.
 - 4. Infrared Partition Sensors: One of each type installed.
 - 5. Control Stations: Quantity equal to one unit for every 30 stations installed, but no fewer than one of each type.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. nLight/Acuity Controls
 - 2. Lutron Electronics, Inc.
 - 3. Cooper (Eaton) Lighting Controls
 - 4. Hubbell Lighting Controls

2.2. GENERAL SYSTEM REQUIREMENTS

- A. Lighting control system will have: a networked backbone to allow for remote or time based operation, intelligent lighting control devices capable of communicating on a digital network, and a system capable of operating in standalone lighting control zones.
- B. Intelligent lighting control devices shall consist of but not be limited to: occupancy sensors, photocell sensors, relays, dimming outputs, low voltage switches, manual switch stations, manual dimming stations, graphic wall control, and intelligent lighting fixtures.
- C. System shall be capable of integrating directly with intelligent LED luminaires in a fashion that integration to the system be achieved through the use of interconnecting Cat5 cable.
- D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- E. All devices within the lighting control system shall be daisy-chained together with Cat5 low voltage cabling in any order
- F. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- G. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or if the management software becomes unavailable.
- H. All switching and dimming for a specific lighting zone shall take place within the device located in the zone itself to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- I. System shall have a primary network control device that is capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- J. System shall have a network communication device that routes communication between control zones and distributes power across up to 8 directly connected zones.
- K. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.
- L. System shall be capable of operating a lighting control zone according to a sequence of operation. Operating modes should be utilized only in manners consistent with local code.
 - 1. Auto-On / Auto-Off (via occupancy sensors)
 - 2. Manual-On / Auto-Off
 - 3. Auto-to-Override On
 - 4. Manual-to-Override On
 - 5. Auto On/Predictive Off

- 6. Multi-Level On (multiple lighting levels per manual button press)
 - M. Control software shall enable logging of system performance data and presenting information in a web-based graphical format or downloadable .CSV file.
 - N. Control software shall enable integration with a BMS via BACnet IP.
- 2.3. CENTRALIZED SYSTEM CONTROL
- A. System shall have a centralized processor capable of communicating and controlling downstream system control devices and linking into an Ethernet.
 - B. Control modules shall be powered by low voltage, and have a backlit LCD display screen.
 - C. User control shall be made via finger-touch buttons with no moving parts. Buttons shall be capable of being locked for security.
 - D. Devices shall have RJ-45 ports for connection to other backbone devices or for connection directly to lighting control zones.
 - E. Devices shall automatically detect all downstream devices.
 - F. Devices shall have a standard and astronomical internal time clock capable of providing time based command to all devices downstream of control module.
 - G. Devices shall have an RJ-45 10/100 BaseT Ethernet connection.
 - H. Devices shall be capable of using a dedicated or DHCP assigned IP address.
- 2.4. CENTRALIZED COMMUNICATION DEVICES
- A. Devices shall have multiple RJ-45 ports.
 - B. Devices shall be capable of aggregating communication from multiple lighting control zones for purpose of minimizing backbone wiring requirement back to centralized system control.
 - C. Devices shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a Cat5 connection.
 - D. Devices shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
- 2.5. POWER PACKS
- A. Power packs shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. 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.

- B. Power packs shall accept and switch 120VAC or 277 VAC, be plenum rated, and provide Class 2 power for multiple sensors.
- C. Power packs shall securely mount to junction location through a threaded ½ inch chase nipple. 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.
- D. Power packs shall incorporate a Class 1 relay and an AC electronic switching device. The AC electronic switching device shall make and break the load, while the relay shall carry the current in the on condition. This system shall provide full 20 Amp switching of all load types, and be rated for 400,000 cycles.
- E. Power packs shall be single circuit, or two circuits. When two circuit power packs, the power packs must be wired directly to circuit breaker. Otherwise, power packs may be wired on the line or load side of the local switch.
- F. All applicable products must be UL / CUL Listed or other acceptable national testing organization.
- G. Slave modules shall be available for switching additional circuits. Slave module has same construction and specification as control module except without power supply function.

2.6. OCCUPANCY SENSORS

- A. Occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
- B. Sensors shall utilize passive infrared technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions.
- C. For applications where a second method of sensing is necessary to adequately detect maintained occupancy, sensors with an additional technology shall be used.
- D. Sensor shall be capable of mounting in multiple locations:
 - 1. Ceiling Mount
 - 2. Corner Mount
 - 3. Wall Mount with on/off switch
 - 4. Fixture Mount
- E. Sensor shall be available with different sensing technologies:
 - 1. Passive Infrared (PIR).
 - 2. Microphonics
 - 3. Ultrasonic
- F. Low voltage sensors shall receive communication and Class 2 low voltage power via

standard Cat5 low voltage cabling with RJ-45 connectors.

- G. Line voltage sensors shall be capable of switching 120/277 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, and ¼ HP motors.
- H. Sensors shall turn lights on only upon infrared detection.
- I. Sensors shall indicate detected motion via a red LED.
- J. Sensor controls shall be behind cover to resist tampering.
- K. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.
- L. Sensors with dimming can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current.
- M. The occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2.7. DAYLIGHT CONTROLS

- A. Low voltage photocell shall accept 12 to 24 VAC or VDC and provide a relay for interface with remote switching system. Sensors shall interface with occupancy sensors, directly with power pack or other system as shown. Sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current.
- B. Low voltage dimming sensors set point shall be automatically calibrated through the sensor's microprocessor by initiating the "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
- C. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
- D. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space.
- E. Dual zone option shall be available for photocell, dimming, or combination units. The second zone shall be controlled as an "offset" from the primary zone and shall be the zone farthest from the natural light source.
- F. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz power. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, and ¼ HP motor load.
- G. Line voltage versions of the above described dimming sensors shall be capable of powering off 120/277 VAC.

2.8. WALL SWITCHES, DIMMERS, AND SCENE CONTROLLERS

- A. All switches shall recess into a single-gang switch box and fit a standard decorator style opening.
- B. Communication and low voltage power shall be delivered to each device via standard Cat5 low voltage cabling with RJ-45 connectors.
- C. All switches shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
- D. Devices with mechanical push-buttons shall be made available with custom button labeling.
- E. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusions as to which of two buttons controls which load is eliminated.
- F. Devices shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
- G. Devices shall be capable of selecting a lighting profile be run by the system's upstream processor so as to implement selected lighting profile across multiple zones.
- H. Refer to details and the "Network Wall Switches Schedule" of the Contract Drawings for specific requirements.

2.9. RELAY AND DIMMING PANELS

- A. Panel shall incorporate up to 4 normally closed latching relays at 120/277 VAC or 2 dual phase 208/480 VAC relays.
- B. Relays shall be rated to switch up to 30A ballast loads at 277 VAC.
- C. Panel shall be capable of 0-10 VDC dimming for each zone.
- D. Power shall be powered from an integrated 120/277 VAC supply.
- E. Panel shall be capable of operating as a networked device.

2.10. BUILDING MANAGEMENT SYSTEM COMPATIBILITY

- A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.
- B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems
- C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.11. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

- A. System shall be capable of reporting lighting system events and performance data back to

the management software for display and analysis.

- B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
- C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO2.
- D. Software shall calculate the allocation of energy savings to different control measures.
- E. Energy savings data shall be calculated for the system as a whole or for individual zones.
- F. User shall be able to customize the baseline run-time hours for a space.
- G. User shall be able to customize up to four time-of-day billings rates and schedules.

2.12. MANAGEMENT SOFTWARE

- A. Every device parameter shall be available and configurable remotely from the software.
- B. The following status monitoring information shall be made available from the software for all devices for which is applicable:
 - 1. Current Occupancy Status
 - 2. Current PIR Status
 - 3. Current Microphonic Status
 - 4. Remaining Occupancy Time Delay
 - 5. Current Photocell Reading
 - 6. Current Photocell Inhibiting State
 - 7. Photocell Transitions Time Remaining
 - 8. Current Dim Level
 - 9. Device Temperature
 - 10. Device Delay Status
- C. The following device identification information shall be made available via the software:
 - 1. Model Number
 - 2. Model Description
 - 3. Serial Number
 - 4. Manufacturing Date Code

5. Custom Label
 6. Parent Network Device
- D. Software shall provide at least three permission levels for users.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine substrate areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Lighting Management System.
- B. Examine rough-in for the network lighting controls to verify actual locations of conduit connections before equipment installation.
- C. Examine walls, floors, ceilings, etc. for suitable conditions where network lighting control equipment will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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. Secure equipment to building structural elements and support according to requirements of Division 26 Section "Hangers and Supports".
- E. Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.
- 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 luminaires.
- G. Label all wiring, cables and enclosures in accordance with Division 26 Section "Electrical Identification".
- H. Systems Integration:
 1. Equipment Integration Meeting Visit
 - a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

- I. Wiring Method:
1. Bus control wire shall be run in accordance with the requirements of this spec, local jurisdiction requirements, or Manufacture’s written requirements whichever is more stringent.
 2. Conductors to Class 2 occupancy sensors or photo-sensors not exceeding 12 feet may be installed in accordance with NEC Article 725 for Class 2 circuits and the support requirements of this Section.
 3. Class 2 control cable over 12 feet in length shall be run in conduit or bundled and run in accordance with communication cable requirements.
 4. Free-run Class 2 cable shall be supported at a minimum of every 6 feet and shall be run above ductwork and other equipment at the truss level to reduce the exposure to damage.
 5. Cable supports shall use double wire ties or equivalent methods that prevent direct contact between the cable and sharp and/or hard surfaces such as running thread rods, pipe supports, and suspended ceiling wires.
 6. Cable supports shall not pinch or overly tighten the cable.
 7. Cable shall not be supported by ductwork, ceiling tiles, or other equipment.
 8. Connections to sensors and other devices shall be strain relieved to the device or a nearby support.
 9. When mounted in a ceiling tile the cable shall include at least 6 feet of coiled cable to allow tiles to be relocated.
 10. Comply with manufacturer’s written instructions for wiring installation or this spec whichever is more stringent.
 11. Install bus wire with the minimum number of splices.
- J. Wiring Within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to equipment manufacturer's written instructions.
- K. Surge Protection: Install field-mounted transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- L. Equipment Grounding: Provide low-impedance “hard” copper earth grounding to ballasts, fixtures, and control mounting boxes in accordance with ballast, lamp, and control manufacturer’s requirements. Floating fixture strike plates and high-impedance “safety grounds” are generally not acceptable and standard UL listed safety grounds may not be sufficient.
- M. 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.

3.3. IDENTIFICATION

- A. Identify components, and power and control wiring in accordance with Division 26 Section "Electrical Identification".
- B. Identify all ceiling mounted controls in blank covered boxes with network number, device address, and type of control located in box.
- C. Label each network wiring pair within 6 inches of connection to control network bus supply or termination block. Each control network wire pair shall be labeled in accordance with Division 26 Identification section and shall include the electrical power panel name and circuit number with which the wire pair is pulled.

3.4. SERVICE AND SUPPORT

- A. Startup and Programming
 - 1. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters
 - a. Qualifications for factory certified field service engineer:
 - 1. Minimum experience of 2 years training in the electrical/electronic field.
 - 2. Certified by the equipment manufacturer on the system installed.
 - b. Make first visit prior to installation of wiring. Review the following:
 - 1. Low voltage wiring requirements.
 - 2. Separation of power and low voltage/data wiring.
 - 3. Wire labeling.
 - 4. Lighting Management Panel locations and installations.
 - 5. Control locations.
 - 6. Computer jack locations.
 - 7. Load circuit wiring.
 - 8. Network wiring requirements.
 - 9. Connections to other equipment and other Lutron equipment.
 - 10. Installer responsibilities.
 - 11. Power Panel locations.
 - c. Make second visit upon completion of installation of Network Lighting Control System:
 - 1. Verify connection of power wiring and load circuits.
 - 2. Verify connection and location of controls.
 - 3. Energize Lighting Management Panels and download system data program.
 - 4. Address devices.
 - 5. Verify proper connection of panel links (low voltage/data) and address panel.
 - 6. Download system panel data to dimming/switching panels
 - 7. Check dimming panel load types and currents and supervise removal of by-pass jumpers.

8. Verify system operation control by control.
 9. Verify proper operation of manufacturers interfacing equipment.
 10. Verify proper operation of manufacturers supplied PC and installed programs.
 11. Configure initial groupings of ballast for wall controls, daylight sensors and occupant sensors.
 12. Initial calibration of sensors.
 13. Obtain sign-off on system functions.
- d. Make third visit to demonstrate and educate Owner's representative on system capabilities, operation and maintenance. See requirements below.

2. Startup

- a. Software configuration
 1. Naming and association of areas and lighting zones.
 - b. After Hours Start-up
 1. Provide factory certified Field Service Engineer to perform manufacturer's start-up procedures outside normal working hours (Monday through Friday, 7a.m. to 5 p.m.)
- B. Training of customer representatives for Lighting Management Software
- C. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.5. FIELD QUALITY CONTROL

- A. Manufacturer Services
1. Aim and Focus Visit
 - a. Facility Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Architect/Engineer to make required lighting adjustments to the system for conformance with the Architect/Engineer's original design intent.
- B. Complete installation and startup checks in accordance with manufacturer's written instructions to include the following:
1. Prefunction - Compliance inspection of all materials, controls, light fixtures.
 2. Activate light fixtures prior to control system activation and verify that all light sources are operating at 100%.
 3. Test that control bus wiring is free of wire-ground and wire-wire shorts and AC line voltage before connecting to the Bus Supply.
- C. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

- E. Reports: Prepare written reports of tests, inspections, verifications and observations indicating and interpreting results. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- G. Verify normal operation of each fixture after installation.
- H. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to backup source and retransfer to normal.
- I. If adjustments are made to lighting control system, retest to demonstrate compliance with standards.

3.6. DEMONSTRATION & TRAINING

- A. Training Visit
 - 1. Lighting Control System Manufacturer to provide 1 day (minimum 6 hours) additional on-site system training to site personnel.
- B. On-Site Walkthrough
 - 1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.
- C. Video Recordings
 - 1. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect Engineer.
 - 2. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
 - 3. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
 - 4. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.7. MAINTENANCE

- A. Capable of providing on-site service support within 24 hours anywhere in continental United States.
- B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.
- C. System Optimization Visit

1. Lighting Control System Manufacturer to visit site six (6) months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

SECTION 261120 - UTILITY INCOMING SERVICE PROVISIONS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

- A. The general provisions of the Contract, including the General Requirements, apply to the work specified in this Section.
- B. Division 26 Section "Common Work Results for Electrical" sections apply to work of this section.

1.2. DESCRIPTION OF WORK

- A. The Contractor shall provide all materials and labor required by the utility for service provisions.
- B. The Contractor shall provide all materials and labor for complete empty conduit systems as shown on the drawings and as specified herein.

1.3. RELATED WORK SPECIFIED ELSEWHERE IN DIVISION 26

- A. Section "Common Work Results for Electrical".
- B. Section "Electrical Systems Analysis".
- C. Section "Raceways and Boxes".
- D. Section "Wiring Devices".
- E. Section "Underground Ductbanks".
- F. Section "Grounding and Bonding".

1.4. UTILITY COMPANY COORDINATION

- A. Contact Miss Utility (1-800-257-7777) prior to any excavation or underground work. The Contractor shall verify the location and depth of all utilities. Provide test pits to verify location and depth of all existing utilities crossing new incoming services.
- B. Contact serving utility companies immediately upon award of Contract. Do not install related equipment until fully coordinated with appropriate utilities.
- C. Provide all Construction Schedules, dates of requested services, outage windows, equipment locations, etc., necessary for utility work.
- D. The Contractor shall ascertain, from the utility companies, the exact amount of work required in connection of the utilities. Work required which is not provided by the utility companies shall be provided by the Contractor.
- E. Provide and coordinate all temporary services with utility companies.

- F. The Contractor shall coordinate the required separation distances for all utilities.
- G. The Contractor shall obtain all permits and permissions required.

1.5. SUBMITTALS

- A. Certificate of Compliance: Contractor shall submit a document certifying that work complies with all utility company requirements including the following:
 - 1. Construction Standards of each Utility Company.
 - 2. Trench and cover Depth.
 - 3. Spacing and Support of Utilities.
 - 4. Installation of underground marking tape.
 - 5. Pull cords and Mandrels.
- B. Submit Certificate of Compliance (and photographs if required) to each utility company for verification and approval.
- C. Include Certificate of Compliance and utility company approvals in O&M Manual.
- D. The Contractor shall provide and submit all required documentation to each utility company, including service application, site plan and coordination drawings.

1.6. QUALITY ASSURANCE

- A. Comply with the requirements of Delaware Electric Cooperative.
- B. Comply with the requirements of NFPA 70, National Electrical Code.
- C. Comply with the NECA Standard of Installation.
- D. Comply with NFPA 70E, National Electrical Safety Code.
- E. Contractor shall have experience with not less than 5 comparable projects for which the Contractor completed service provisions with each utility. Contractor shall be familiar with all current utility requirements and guidelines.
- F. Obtain utility company inspector's approval for all work.

PART 2. PRODUCTS

2.1. ELECTRIC UTILITY COMPANY PROVISIONS

- A. The electric utility company is Delaware Electric Cooperative.
- B. Coordinate service entrance equipment and layout with Power Company prior to ordering or installing any service entrance equipment.

- C. Furnish and install all incoming raceway.
- D. Coordinate cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.
- E. Provide pad for utility company's transformer as required by the Utility. If utility company furnishes pre-cast transformer pad, schedule pick up/delivery with utility company.
- F. Provide grounding and clearances as required by the Utility.
- G. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, the Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.
- H. The Contractor shall ascertain from the utility companies, the available short circuit fault current.
- I. Equipment for Utility Company's Electric Metering:
 - 1. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
 - 2. Meter Sockets: Comply with requirements of electrical power utility company.
 - 3. Housing: NEMA 250, Type 3R enclosure.
- J. All mainline disconnects, tap boxes, C/T cabinets, meter sockets, and other service equipment shall be approved by the utility company prior to ordering.

2.2. TYPICAL INCOMING SERVICE PROVISIONS

- A. Pull Cords: ¼-inch nylon pull cord with 500 lb. minimum tensile strength in each conduit.
- B. Conduit, Elbows, and Couplings: UL Schedule 40, EB-35, DB-60, DB-120, or ANSI/ASTM F-512 as required by utility for the specific application.
- C. Spacers: Every 4 feet of conduit.
- D. Splice Boxes: Purchase from utility company. Provide as required.
- E. Utility Holes: Purchase from utility company. Provide as required.
- F. Underground Marking: Provide detectable warning tape over all conduits.
- G. Bends: Minimum 5 foot radius (horizontal) and 36-inch radius (vertical).
- H. Concrete for encasement: Minimum 3,000 psi, As specified in Division 26 Section, "Underground Ductbanks", unless otherwise noted on the Drawings, with air entrainment and pea gravel.
- I. Backfill: Virgin soil/select backfill only. Backfill shall be stone dust, rock-free earth, or

top soil with no stones larger than 1-1/2-inches in diameter permitted.

- J. Miscellaneous Materials: Provide bushings, bell ends, conduit plugs and other miscellaneous materials as required by utility companies.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Mandrel: Contractor shall pull a mandrel (1/2-inch smaller in diameter than the conduit, and six inches long) through each conduit.
- B. Pull Cords: Pull cords shall be left in all conduits, after mandrel pull.
- C. Coordination: Coordinate location of telephone and CATV wall spaces, raceways, and boxes, as necessary, to interface installation of telephone and CATV systems with other work.
- D. Bushings: Provide conduit bushing at each end of all conduits.
- E. Bell Ends & Plugs: Provide bell ends and plugs for each conduit.
- F. Sealing Conduits: Provide duct sealant in each conduit after utility cable is installed.

3.2. UTILITY COMPANY ELECTRIC-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company. Provide lugs as required by utility.

3.3. PREPARATION

- A. Contractor shall provide conduits at all street or road crossings for all utility facilities.
- B. Provide a level area at final grade for all transformer, pedestal, and utility equipment locations.
- C. Coordinate utility line separation requirements between electric, water, sewer, gas, telephone and CATV.
- D. Contractor shall clear area for all utility cables of rubble, debris, stumps, and other obstructions.

END OF SECTION

SECTION 262200 - 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 dry-type distribution and high harmonic/non-linear load transformers rated 1000 V, and less.

1.3. SUBMITTALS

- A. Product Data: Include data on features, components, ratings, dimensions, weight, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.
- B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.
- C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.
- D. Field Test Reports: Indicate and interpret test results for tests specified in Part 3 of this Section.
- E. Maintenance Data: For transformers to be included in the Operation and Maintenance Manuals specified in Division 01 and Division 26 Section, "Common Work Results for Electrical".
- F. Project Record Documents: Record actual transformer locations.

1.4. QUALITY ASSURANCE

- A. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.

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 is not in a space that is continuously under normal control of temperature and humidity.

- B. Store and protect equipment in a dry location with uniform temperature. Cover ventilation openings to keep dust out.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.
 - 1. Square D Company. (Basis of Design)
 - 2. Eaton/Cutler-Hammer.
 - 3. Acme Electric Corp.; Transformer Division.
 - 4. General Electric (GE)

2.2. TRANSFORMERS, GENERAL REQUIREMENTS

- A. Description: Factory-assembled and tested, air-cooled units of types specified, designed for 60-Hz service.
- B. Coils: Continuous aluminum windings without splices, except for taps.
- C. Coil Conductors: Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies.
- D. Internal Coil Connections: Brazed or pressure type.
- E. Enclosure: Class complies with NEMA 250 for the environment in which installed. Comply with NEMA ST 20.
- F. Nameplates: Include transformer connection data and overload capacity based on rated allowable temperature rise.
- G. Basic Impulse Level: 10 kV for transformers less than 300 kVA.

2.3. ENERGY EFFICIENT GENERAL PURPOSE TRANSFORMERS

- A. Description
 - 1. Dry-Type distribution transformers for general loads, single and/or three-phase, with primary and secondary voltages of 600 V and less and capacity ratings 15kVA through 750kVA.
- B. Standards
 - 1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.
 - 2. Conform to the requirements of ANSI/NFPA 70.

3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL 1561.
4. Transformers shall be low loss type with minimum efficiencies per US Department of Energy (DOE) 2016 Standards, as defined in the Code of Federal Regulations, 10 CFR 431.192.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO 9001:1994 SIC3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.
2. Transformers 15kVA and larger shall be 150 degrees C temperature rise above 40 degrees C ambient. Transformers 25kVA and larger shall have a minimum of 4 – 2.5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.
3. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.
2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturated point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure, but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

F. Sound Levels

1. Sound levels shall be warranted by the manufacturer not to exceed the following:
15 to 50 KVA - 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to 1000kVA – 64dB; 1001 to 1500kVA – 65dB; 1501 to 2000kVA – 66dB

2.4. HIGH HARMONIC LOAD (K-RATED) TRANSFORMERS

A. Description

1. Dry type distribution transformers for non-linear loads, single and/or three phase, primary and secondary voltage of 600V and less and capacity ratings of 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.
2. Conform to the requirements of ANSI/NFPA 70.
3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL1561.
4. Transformers shall be low loss type with minimum efficiencies per US Department of Energy (DOE) 2016 Standards, as defined in the Code of Federal Regulations, 10 CFR 431.192.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO9001:1994 SIC 3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.
2. Neither the primary nor the secondary temperature shall exceed 220 degree C at any point in the coils while carrying their full rating of non-sinusoidal load. Transformers are to be UL listed and labeled for K-9 K-13 as defined as the sum of fundamental and harmonic 1 h per UL 1561. Transformers evaluated by the UL K factor evaluation shall be listed for 115 150 degrees C average temperature rise. K factor listed transformers rated at 150 degrees C rise shall not be acceptable.
3. K factor rated transformers shall have an impedance range of 3% to 5% and shall have a minimum reactance of 2% in order to help reduce neutral current when supplying loads with large amounts of third harmonic current.
4. Transformers 15kVA and larger shall have a minimum of 6 – 2.5% full capacity

primary taps for 480V primaries and a minimum of 2 – 5% fully capacity taps for 208V primaries. Exact voltage and taps to be as designated on the plans or the transformer schedule.

5. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.
2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. The core laminations shall be clamped together with steel angles. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.
5. Transformers shall be supplied with quality, full width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:
 - a. Common Mode: 0 to 1.5kHz – 120dB; 1.5kHz to 10kHz – 90dB; 10kHz to 100kHz – 65dB; 100kHz to 1MHz – 40dB
 - b. Transformer Mode: 1.5kHz to 10kHz – 52dB; 10kHz to 100kHz – 30dB; 100kHz to 1MHz 30dB
6. Sound Levels
 - a. Sound levels shall be warranted by the manufacturer not to exceed the following:
 - i. 15 to 50kVA – 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to 1000kVA – 64dB.

2.5. BUCK-BOOST TRANSFORMERS

- A. Description: Insulating autotransformers with a single winding with two end terminals, and one or more terminals at intermediate tap points, which are used to slightly adjust an application's voltage up or down.
- B. Ratings / Electrical Characteristics:
 - 1. Contractor shall select primary and secondary voltages and VA rating based on application and load being served. The following options shall be available at a minimum:
 - a. 120V x 240V primary with a 12/24V or 16/32V secondary
 - b. 240V x 480V primary with a 24/48V secondary
 - c. 50VA to 3kVA
 - 2. Temperature Rise:
 - a. 50VA through 150VA - 55°C
 - b. 250VA through 500VA - 80°C
 - c. 750VA through 3kVA - 115°C
- C. Transformers shall be designed, manufactured and tested in accordance with the following standards:
 - 1. UL 506 - "Specialty Transformers"
 - 2. ANSI Z535.3 - "American National Standard for Criteria for Safety Symbols"
 - 3. NEMA ST20 - "Dry Type Transformers for General Applications"
- D. Enclosure: Transformers shall be equipped with a wall-mounted NEMA 3R rated enclosure designed and constructed for indoor or outdoor use.
- E. Basis of Design: Square D Company, Class 7414.

2.6. FINISHES

- A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.
- B. Outdoor Units: Comply with ANSI C57.12.28.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Comply with safety requirements of IEEE C2.
- B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

- C. Identify transformers and install warning signs according to Division 26 Section “Electrical Identification”.
- D. 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.
- E. Install transformers in accordance with NECA SI, as indicated on the Drawings, and Manufacturer's published instructions, at locations as indicated on the Drawings.
 - 1. Use Manufacturer-approved mounting brackets for transformers supported from building structure.
 - 2. Securely anchor transformers to concrete pad for floor-mounted transformers.
 - 3. Provide working clearances in conformance with NFPA 70.
 - 4. Provide both, primary and secondary protection using fuses or circuit breakers as indicated on the Drawings.
- F. Set transformers plumb and level.
- G. Use minimum two (2) foot length flexible conduit for connections to transformer case. Make conduit connections to side panel of enclosure.
- H. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure.
- I. Provide minimum 4-inch high concrete pad for floor-mounted transformers. Refer to Division 26 Section, “Common Work Results for Electrical” for installation requirements.
- J. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2. GROUNDING

- A. Separately Derived Systems: Comply with requirements of National Electrical Code Article 250.30 – The grounding electrode conductor (GEC) connection shall be made at the source of the separately derived system (i.e. the transformer) in the transformer enclosure, where the system bonding jumper shall also be installed. Provide supply-side bonding jumper from transformer to first disconnecting means or overcurrent device after the transformer.
- B. Comply with Division 26 Section “Grounding and Bonding” for materials and installation requirements.
- C. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

3.3. FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection:
1. Inspect for defects and physical damage, labeling, and compliance with requirements of drawings and schedules.
 2. Clean transformers using Manufacturer's approved methods and materials.
 3. Verify that transformer nameplates are installed and accurate.
 4. Verify that transformer phase identification nameplates are installed.
 5. Verify that transformer arc flash hazard labels are installed.
 6. Check mounting, area clearances, and alignment and fit of components.
 7. Check tightness of bolted electrical connections with calibrated torque wrench.
 8. Refer to manufacturer's instructions for proper torque values.
 9. Verify that neutral bar is bonded to ground bar with appropriately sized bonding jumper.
 10. Verify that equipment ground bar is bonded to transformer enclosure. Securing ground bar to vent opening is not acceptable.

3.4. CLEANING

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5. ADJUSTING

- A. Record transformer secondary voltages at each transformer for at least 48 hours of typical occupancy. 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 test report recording output voltages and tap settings.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

- A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.
- B. Provide design and engineering, labor, material, equipment, related services and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for panelboards as required for the complete performance of the work, and as shown on the Drawings and as specified herein.
- C. Panelboards shall be fully rated for the AIC identified on the panelboard schedules on the Contract Drawings.
- D. Related Sections include the following:
 - 1. Division 26 Section "Common Work Results for Electrical" for general materials and installation methods.
 - 2. Division 26 Section "Electrical Identification" for labeling materials.
 - 3. Division 26 Section "Electrical Systems Analysis" for engineering analysis involving panelboards specified herein, including but not limited to short-circuit analysis.

1.3. REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. American Society of Testing Materials (ASTM):
 - 1. ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or inspection of Materials Used in Construction."
- C. Federal Specifications (FS):
 - 1. FS W-C-375, "Circuit Breakers, Molded Case, Branch Circuit and Service."
- D. International Electrical Testing Association (NETA):
 - 1. NETA ATS, "Acceptance Testing Specifications for Electrical Power Distribution

Equipment and Systems.”

- E. International Organization for Standardization (ISO):
 - 1. ISO 9001, “Quality Management Systems – Requirements.”
- F. National Electrical Contractors Association (NECA):
 - 1. NECA 407, “Standard for Installing and Maintaining Panelboards.”
- G. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA PB 1, “Panelboards.”
 - 2. NEMA PB 1.1, “General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.”
 - 3. NEMA PB 1.2, “Application Guide for Ground Fault Protective Devices.”
- H. National Fire Protection Association (NFPA):
 - 1. NFPA 70, “National Electrical Code.”
 - 2. NFPA 70B, “Electrical Equipment Maintenance.”
 - 3. NFPA 70E, “Standard for Electrical Safety in the Workplace.”
- I. Underwriters Laboratories, Inc. (UL):
 - 1. UL 50, “Standard for Enclosures for Electrical Equipment.”
 - 2. UL 67, “Standard for Panelboards.”
 - 3. UL 489, “Standard for Molded-Case Circuit Breakers and Circuit Breaker Enclosures.”
 - 4. UL 943, “Standard for Ground-Fault Circuit Interrupters.”
 - 5. UL 1449, “Standard for Surge Protective Devices.”

1.4. SUBMITTALS

- A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.
 - 1. Submit product data for each type of panelboard, overcurrent protective device, surge protective device, ground fault circuit interruptor accessory, and component indicated.
 - 2. Include dimensions and manufacturer’s technical data on features, performance, electrical characteristics, ratings, and finishes of individual protective devices and auxiliary components.

- B. Shop Drawings: Include the following for each panelboard:
 - 1. Dimensioned Plans: Show dimensioned enclosure plans and elevations, including required clearances and service space.
 - 2. Component and Device Lists: Show tabulations of installed devices, features and voltage rating.
 - 3. Single-Line Diagram: Show main- and branch-bus current ratings and short-time and short-circuit ratings of panelboards.
 - 4. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed and field-installed wiring, and between components provided by the manufacturer and those provided by others.
 - 5. Nameplate Legends: Submit sample equipment nameplates for panelboards.
- C. Quality Control Submittals: Submit field quality control test reports certified by testing agency.
- D. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Submit operation and maintenance data for panelboards to include in operation and maintenance manuals specified in Division 01.
 - 2. Warranty Data: Submit manufacturer's standard warranty documents.
 - 3. Panelboard Circuit Directories: For installation in panelboards. Submit final versions after load balancing.
 - 4. Project Record Data: Record actual locations of panelboards, indicating actual branch circuit arrangement.

1.5. QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of panelboards of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
- B. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing panelboards similar in type and scope to that required for this Project.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing

Laboratory as defined in OSHA Regulation 1910.7.

1.6. DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
- B. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.
- C. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- D. Store so condensation will not occur on or in panelboards. Provide temporary heaters as required to avoid condensation.
- E. Handle panelboards according to NEMA PB 1.1. Use only factory-installed lifting provisions.

1.7. PROJECT CONDITIONS

- A. Environmental Requirements: Do not install switchboards until space is enclosed and weatherproof, wet work space is completely and nominally dry, overhead work is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.
- B. Verify Dimensions: Verify NEC and all Code clearance requirements by field measurements. Locate switchboard to meet installation tolerances.
- C. Determine suitable path for moving switchboard into place considering Project conditions.
- D. Revise locations and elevations from those indicated as required to suit Project conditions.

1.8. WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

1.9. EXTRA MATERIALS

- A. Keys: Provide two (2) spares of each type of panelboard cabinet lock.
- B. Touchup Paint: Provide one (1) standard size canisters of manufacturer's touch-up paint for every ten (10) panelboards, finish to match standard enclosure finish as specified herein. Furnish at least one (1) canister of touch-up paint.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers; no other manufacturers are acceptable:
1. Square D Company. (Basis of Design)
 2. Eaton Corp.; Cutler-Hammer Products.
 3. Siemens Energy & Automation Inc.
 4. General Electric (GE)

2.2. FABRICATION AND FEATURES

- A. Enclosures: Provide steel enclosures, in compliance with NEMA PB1, suitable for flush- or surface-mounting as indicated on the Drawings. Type as indicated on the Drawings, unless otherwise indicated to meet environmental conditions at installed location as indicated below:
1. Dry, Interior Locations: NEMA 1
 2. Damp, Wet Interior Locations: NEMA 3R
 3. Damp, Wet Exterior Locations: NEMA 3R
- B. Enclosure Finish for Indoor Units: A minimum of one (1) coat of factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- C. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush-mounted panelboards shall overlap box, unless otherwise indicated.
- D. Buses and Connections: Three phase, four wire, unless otherwise indicated.
1. Bus Composition: Silver-plated or tin-plated copper, hard-drawn, minimum of 98 percent conductivity. Plating shall be applied continuously to bus work. The panelboard bussing shall be of sufficient cross-sectional area to meet UL 67 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown on the Drawings. Coordinate bus short circuit rating with available fault current. Size in accordance with NEMA PB 1.
 2. Phase and Neutral Buses: Provide mechanical lugs to accommodate the quantity, size, and material of the conductors shown on the Contract Drawings.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
 4. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.
 5. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral

cables.

- E. Future Devices: Equip with mounting brackets, supports, bus connections, and appurtenances for the overcurrent protective device ampere ratings indicated on the Drawings.
- F. Directory Frame: Clear plastic cardholder, mounted inside each panelboard door.
- G. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.
- H. Special Features: Include the following features for panelboards as indicated:
 - 1. Provide 200 percent rated neutral bus for all computer and non-linear loads.
 - 2. Subfeed: Over-current protective device or lug provision as indicated.
 - 3. Feed-Through Lugs: Provide mechanical lugs to accommodate the quantity, size, and material of the conductors shown on the Contract Drawings.
 - 4. Gutter Barrier: Arranged to isolate section of gutter as indicated.

2.3. OVERCURRENT PROTECTIVE DEVICES

- A. Overcurrent protective devices include, but are not limited to, the following:
 - 1. Electronic trip circuit breakers.
 - 2. Thermal magnetic circuit breakers.
- B. Molded-Case Circuit Breaker Features and Accessories:
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Lugs: Mechanical style, suitable for quantity, size/gauge, and material of conductors indicated.
 - 3. Application Listing: Appropriate for application, including switching lighting loads (Type SWD) or heating, air-conditioning, and refrigerating equipment (Type HACR).
 - 4. Handle Padlock Attachment: Circuit breakers in panelboards shall be equipped with fixed handle padlock attachment to allow padlocking the circuit breaker in the ON or OFF position at the following locations:
 - a. Main circuit breakers in all panelboards.
 - b. Branch or sub-feed circuit breakers serving other panelboards.
 - c. Branch or sub-feed circuit breakers serving transformers.
 - d. Branch or sub-feed circuit breakers serving variable frequency drives.
 - e. Other locations as indicated on the Contract Drawings.

5. Handle Clamp Attachment: Circuit breakers in panelboards shall be equipped with removable handle clamp attachments to prevent accidental operation of the circuit breaker at the following locations:
 - a. Branch circuit breakers serving emergency lighting and exit signs.
 - b. Branch circuit breakers serving fire alarm equipment.
 - c. Branch circuit breakers serving telecommunications equipment.
 - d. Branch circuit breakers serving refrigerators.
 - e. Other locations as indicated on the Contract Drawings.
6. Ground Fault Protection: Integral to circuit breaker with adjustable pickup and time delay settings, push-to-test feature, and ground-fault indicator.
7. Shunt Trip: 120 volt trip coil energized from separate circuit.
8. Auxiliary Contacts: Two SPDT switches with “a” and “b” contacts; “a” contacts shall mimic circuit breaker contacts, “b” contacts shall operate in reverse of circuit breaker contacts.

2.4. POWER DISTRIBUTION PANELBOARDS

A. Interior

1. Continuous main current ratings as indicated on Contract Drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests in accordance with UL 67.
2. Provide UL listed short-circuit current ratings (SCCR) as indicated on the Contract Drawings, not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main circuit breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.
3. Minimum short-circuit current ratings for distribution panelboards shall be verified by short circuit analysis specified under Division 26 Section “Electrical Systems Analysis” prior to ordering equipment.
4. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
5. The bussing shall be fully rated with sequentially phased branch distribution. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.
6. Interior trim shall be of dead-front construction to shield user from all energized parts.

7. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
8. A solidly bonded equipment ground bar shall be provided.
9. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted neutral will not be acceptable.

B. Main Circuit Breakers – Electronic Trip Molded Case Type

1. Electronic trip, molded case, 80% rated circuit breaker with Micrologic® interchangeable ammeter trip unit with the following time/current response adjustments:
 - a. Long Time Pickup
 - b. Long Time Delay
 - c. Short Time Pickup
 - d. Short Time Delay
 - e. Instantaneous Settings
2. All adjustments shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
3. Circuit breaker trip system shall be microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.
4. Sensor ampere ratings shall be as indicated herein or on the Drawings.
5. Local visual trip indication for overload, short circuit trip occurrences.
6. Long time pickup indication shall signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker.
7. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
8. Provide phase loss/failure relay that will trip main circuit breaker on loss of any single phase. Main circuit breaker shall not trip during total power outage or loss of all three phases.
9. Basis of Design: Square D Company, Micrologic® Power Trip Units.

C. Group Mounted Circuit Breakers Through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
2. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit

breaker(s) of different frame sizes shall be capable of being mounted across from each other.

3. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
4. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

D. Electronic Trip Molded Case Circuit Breakers

1. Electronic trip, molded case, 80% rated circuit breaker(s) with Micrologic® interchangeable ammeter trip unit and the following time/current response adjustments:
 - a. Long Time Pickup
 - b. Long Time Delay
 - c. Short Time Pickup
 - d. Short Time Delay
 - e. Instantaneous Settings
2. All adjustments shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
3. Circuit breaker trip system shall be micro-processor based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.
4. Sensor ampere trip ratings shall be as indicated on the Drawings.
5. Local visual trip indication for overload, short circuit [and ground fault] trip occurrences.
6. Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

E. Thermal Magnetic Molded Case Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
2. Ampere ratings shall be as shown on the Contract Drawings.
3. Ampere interrupting capacity ratings shall be as shown on the Contract Drawings, but not less than 18,000 AIC RMS symmetrical amperes at rated voltage.

F. Enclosures

1. Type 1 Enclosures
 - a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvanized steel will not be acceptable.

- b. Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
- c. Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
- d. Trim front door shall be 4-piece surface and shall have rounded corners and edges free of burrs.
- e. Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike.

G. Basis of Design – Square D Company, I-LINE Distribution Panelboards.

2.5. LIGHTING AND APPLIANCE PANELBOARDS

A. Interior

- 1. Minimum short-circuit current ratings shall be as indicated on the Contract Drawings, but not less than 10,000 AIC RMS symmetrical amperes for 120/208V panelboards, and 18,000 AIC RMS symmetrical amperes for 277/480V panelboards.
- 2. Minimum short-circuit current ratings shall be verified by short circuit analysis specified under Division 26 Section “Electrical Systems Analysis” prior to ordering equipment.
- 3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat rise tests conducted in accordance with UL 67. Bus bar plating shall run the entire length of the bus bar.
- 4. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Article 230.
- 5. All current carrying parts shall be insulated from ground and phase to phase by high dielectric strength thermoplastic.
- 6. Interior trim shall be of dead front construction to shield user from energized parts. Dead front trim shall have preformed twist-outs covering unused mounting space.
- 7. Interiors shall be field convertible for top or bottom incoming feed.
- 8. Main circuit breakers shall be vertically mounted.
- 9. Sub-feed circuit breakers shall be vertically mounted.
- 10. Interior leveling provisions shall be provided for flush mounted applications.
- 11. Main lug interiors up to 400 amperes shall be field convertible to main breaker.

B. Main Circuit Breakers

1. Main circuit breakers shall have an over-center, trip free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and instantaneous magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and be factory calibrated to operate in a 40 degrees C ambient environment. Thermal elements shall be ambient compensating above 40 degrees C.
2. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push to trip button for maintenance and testing purposes.
3. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.

C. Branch Circuit Breakers

1. Molded case branch circuit breakers shall have bolt-on type bus connectors.
2. Circuit breakers shall have an over-center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and instantaneous magnetic trip elements in each pole. Two and three pole circuit breakers shall have common tripping of all poles.
3. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI TRIP indicator appearing in the clear window of the circuit breaker housing.
4. Circuit breakers serving transformers or other panelboards shall be equipped with factory-installed, fixed, handle padlock attachment to allow padlocking circuit breakers in the OFF only position.

D. Enclosures

1. Type 1 Enclosures
 - a. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
 - b. Boxes shall have removable end-walls with knockouts located on one end. Boxes shall have welded interior mounting studs.
 - c. Fronts shall meet strength and rigidity requirements per UL 50 standards. Front shall be finished with ANSI 49 gray baked enamel electrodeposited over cleaned phosphatized steel.
 - d. Panelboards shall have hinged front cover with entire front trim hinged to box with standard door within hinged front cover.
 - e. Front shall not be removable with the door locked.
 - f. Doors on front shall have rounded corners and edges shall be free of burrs.

- g. A clear plastic directory card holder shall be mounted on the inside of the door.
- h. All lock assemblies shall be keyed alike, one (1) key shall be provided with each lock.

2. Type 3R/5/12 Enclosures

- a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be finished with ANSI 49 gray polyester acrylic powder paint over cleaned phosphatized steel.
- b. Doors shall be gasketed and be equipped with a locking vault handle.
- c. A clear plastic directory card holder shall be mounted on the inside of the door.
- d. All lock assemblies shall be keyed alike, one (1) key shall be provided with each lock.

E. Basis of Design – Square D Company, NQ/NF Series Panelboards.

2.6. SURGE PROTECTIVE DEVICES

A. Description: Integrated Surge Protective Devices (SPDs) in panelboards.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Square D Company - "IMA" Series
- 2. Eaton Corporation; Cutler-Hammer Products
- 3. Siemens Energy & Automation, Inc.
- 4. General Electric (GE)

C. The manufacturer of the SPD shall be the same as the manufacturer of the electrical distribution equipment in which the SPDs are installed and shipped.

D. Standards - Most recent editions of:

- 1. Underwriters Laboratories:
 - a. UL 1449 - "Surge Protective Devices"
 - b. UL 1283 - "Electromagnetic Interference Filters"
- 2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002
- 3. National Electrical Code: Article 285 - "Surge Protective Devices, 1 kV or Less"

E. Listing Requirements:

- 1. SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet the intent of this Specification.

- F. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per 2008 NEC Article 285.6
- G. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including Neutral-Ground (N-G), shall be protected by internal overcurrent and thermal over-temperature controls.
- H. SPD shall be UL labeled with 20kA I-nominal (I-n) for compliance to UL 96A - "Installation Requirements for Lightning Protection Systems" for Master Label Certificate, and NFPA 780 - "Standard for the Installation of Lightning Protection Systems."
- I. Minimum surge current capability (single pulse rated) per phase shall be as follows:
 - 1. Distribution Panelboards: 240kA
 - 2. Branch Panelboards: 120kA
- J. SPD shall provide surge current paths for all modes of protection: Line-Neutral (L-N), Line-Ground (L-G), and Neutral-Ground (N-G) for Wye systems; Line-Line (L-L), and Line-Ground (L-G) in Delta and impedance grounded Wye systems.
- K. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage L-N	L-G	L-L	N-G
208Y/120V	700V	700V	1200V
480Y/277V	1200V	1200V	1800V
- L. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage MCOV	Allowable System Voltage Fluctuation (%)
208Y/120V	150V
480Y/277V	320V
- M. SPD shall be constructed of one self-contained suppression module per phase.
- N. Visible indication of proper SPD connection and operation shall be provided. SPD shall include LED indicator lights which shall indicate which phase as well as which module is fully operable.
- O. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.
- P. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.
- Q. SPD shall be equipped with an audible alarm which shall activate when any one of the

surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

- R. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.
- S. Terminals shall be provided for necessary power and ground connections.
- T. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory loss upon loss of AC power.
- U. SPD shall have a warranty period of ten (10) years from date of invoice and shall include unlimited replacement of suppression modules within the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

2.7. IDENTIFICATION

- A. Nameplates: Engraved nameplates shall be provided for all panelboards. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master Nameplate giving panelboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.
- B. Panelboards used as service-entrance equipment shall be labeled as the same.
- C. Refer to Division 26 Section "Electrical Identification" for additional information.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine elements and surfaces to receive switchboard for compliance with installation tolerances and other conditions affecting performance of panelboards.
 - 1. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 2. Verify dimensions of panelboard and working space clearances.

3.2. INSTALLATION

- A. Install panelboards and accessory items according to NEMA PB 1.1.
- B. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- C. Panelboard dead fronts shall remain intact except where tabs are removed for circuit breakers. Install filler plates in unused pole spaces not filled by a circuit breaker that are accidentally opened. Do not remove all tabs in dead front and fill the same with filler

plates.

- D. Provision for Future Circuits at Flush-Mounted Panelboards: Stub 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future and/or 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade, in accordance with the following schedule:

Total Number of Single Pole Spares and Spaces	Number of 1-inch Empty Conduits
1 – 3	Two
4 – 6	Three
7 – 9	Four
10 – 12	Five
13 – 20	Ten
21 – 32	Fifteen

- E. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.
- F. Two or three pole circuit breakers shall be common trip type. Single pole breakers with handle ties will not be permitted.
- G. Tandem circuit breakers will not be permitted.
- H. Provide ground buses in panelboards as indicated on the Drawings. Ground bus shall be similar in all respects to neutral bus.
- I. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, Application Guide for Ground Fault Circuit Interrupters.
- J. Provide handle clamps for all branch circuit breakers serving telephone and communications equipment, refrigerators, exit signs, fire alarm system controls, etc. to prevent accidental operation.
- K. Branch circuit breakers serving electric water coolers shall be GFCI type for personnel protection (5mA).
- L. Branch circuit breakers serving vending machines shall be GFCI type for personnel protection (5mA).
- M. Height: Six-feet, six-inches to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above the floor. Top breaker maximum height not to exceed 6 feet 7 inches per NEC Article 404.8.
- N. Do not energize or connect service-entrance equipment and panelboards to their sources until surge protective devices are properly installed and connected.

3.3. GROUNDING

- A. Make equipment grounding connections for panelboards as indicated.
- B. Provide ground continuity to main electrical ground bus as indicated.

3.4. CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Neutral and ground conductors shall be isolated and terminated only at their respective bus bars. There shall only be one neutral-ground connection in service-entrance equipment by means of a removable main bonding jumper. Neutral and ground terminations at one bus bar shall not be acceptable.

3.5. IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Electrical Identification".
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws. Refer to Division 26 Section "Electrical Identification" for nameplate requirements.
- C. Panelboard Circuit Directories: Provide a typewritten directory, indicating plainly what each branch circuit of the panelboard serves and where. Provide additional information as required by NEC. Spaces and spare breakers shall be written in pencil. Copying of Contract Drawing Panel Schedules and Descriptions shall not be acceptable. Circuit directory shall reflect final circuit connections, loads and locations after balancing of panelboard loads.

3.6. FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 - 2. Clean devices using Manufacturer's approved methods and materials.
 - 3. Verify that panelboard nameplates are installed and accurate.
 - 4. Verify that panelboard phase identification nameplates are installed.
 - 5. Verify that panelboard arc flash hazard labels are installed.
 - 6. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 7. Check panelboard mounting, area clearances, and alignment and fit of components.

8. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 9. Perform visual and mechanical inspection and related work for over-current protective devices.
 10. Verify that all neutral conductors are bonded to the system ground at the service-entrance prior to installation of the surge protective device.
 11. Verify that neutral-ground bonds do not exist at locations that are not service entrances or separately derived power sources.
- B. Panelboard Electrical Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
1. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.
 2. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
 3. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
 4. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.
 5. Make continuity tests of each circuit. Refer to Division 26 Section "Conductors and Cables" for testing specific to feeder conductors.
 6. Perform ground resistance test on system and equipment ground connections
 7. Test main and subfeed over-current protective devices.
 8. Test ground fault devices in accordance with NETA ATS 7.14.
 9. Test phase loss relay(s) at service-entrance equipment to verify that phase loss relays are fully operational.
 10. NETA Testing:
 - a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers, for all devices rated 100-amperes and larger.
 - b. Compare test results with specified performance or manufacturer's data.

SECTION 262726 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. Straight-blade receptacles.
 - 2. GFCI receptacles.
 - 3. Locking receptacles.
 - 4. Weather-Resistant receptacles.
 - 5. Toggle switches.
 - 6. Wall-box occupancy sensor switches.
 - 7. Device plates.
 - 8. Pendant cord connector devices.
 - 9. Cord and plug sets.
 - 10. Emergency pushbuttons.

1.3. DEFINITIONS

- A. GFCI: Ground-Fault Circuit Interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- C. PIR: Passive Infrared.
- D. RFI: Radio-Frequency Interference.
- E. US: Ultra- Sonic.
- F. WR: Weather-Resistant.

1.4. SUBMITTALS

- A. Product Data: For each product specified, indicating configurations, finishes, dimensions, and manufacturer's instructions.

- B. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 01.

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.
- B. Comply with NFPA 70.
- C. Comply with NECA Standard of Installation.
- D. Codes: Provide wiring devices conforming to the following:
 - 1. American National Standards Institute (ANSI): Provide lugs and receptacle devices constructed in accordance with ANSI C73, Attachment Plugs and Receptacles, Dimensions of.
 - 2. Institute of Electrical and Electronics Engineers (IEEE): Construct and install wiring devices in accordance with requirements of IEEE 241, Recommended Practice for Electric Power Systems in Commercial Building.
 - 3. National Electrical Manufacturers Association (NEMA): Provide wiring devices constructed and configured in accordance with the requirements of
 - a. WD1: General Requirements for Wiring Devices
 - b. WD5: Special Purpose Wiring Devices
 - c. WD6: Wiring Devices - Dimensional Requirements.
 - d. WD7: Occupancy Motion Sensors Standard, 2011 Edition
 - 4. National Fire Protection Association (NFPA): Comply with NFPA 70, National Electrical Code, as applicable to construction and installation of electrical wiring devices.
 - 5. Underwriters Laboratories, Inc. (UL): Provide wiring devices which are UL listed and comply with the requirements of:
 - a. 20: General-Use Snap Switches.
 - b. 498: Attachments, Plugs and Receptacles
 - c. 514A: Metallic Outlet Boxes.
 - d. 514B: Fittings for Conduit and Outlet Boxes.
 - e. 514C: Non-Metallic Outlet Boxes, Flush-Device Boxes, and Covers
 - f. 943: Ground-Fault Circuit Interrupters

1.6. COORDINATION

- A. Receptacles for Equipment Furnished with Cord and Plug Sets: Match plug configurations.
- B. Cord and Plug Sets: Match equipment requirements.

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. Deliver extra materials to Owner.
 - 1. Wallbox Occupancy Sensor Switches: One for each ten installed, but not less than one of each type.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- 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. Wiring Devices:
 - a. Hubbell, Inc.; Wiring Devices Division
 - b. Pass & Seymour/Legrand; Wiring Devices Division
 - c. Leviton Manufacturing Co., Inc.
 - d. Eaton/Cooper; Wiring Devices Division
 - e. Lutron Electronics, Inc.
 - 2. Wall-box Occupancy Sensor Switches:
 - a. Watt Stopper
 - b. Lutron Electronics, Inc.
 - c. Sensor Switch
 - d. Hubbell, Inc; Wiring Devices Division
 - e. Pass & Seymour/Legrand
 - f. Leviton Manufacturing Co, Inc.
 - g. Eaton/Cooper; Wiring Devices Division
 - 3. Retractable Cord Reels:
 - a. Reelcraft Industries
 - b. Hubbell Inc., Wiring Devices Division
 - c. Pass & Seymour/Legrand
 - d. Ericson Manufacturing Company
 - e. Appleton Electric Company
 - f. Graco Inc.
 - 4. Emergency Pushbuttons:
 - a. Safety Technology International, Inc. (STI)
 - b. Square D Company
 - c. Crouse-Hinds

2.2. STRAIGHT BLADE RECEPTACLES

- A. General Requirements

1. Straight blade receptacles shall have the following basic features:
 - a. One-piece brass mounting strap with integral ground for low resistance of fault currents.
 - b. Auto-ground clip to assure positive ground.
 - c. Impact-resistant nylon face and thermoplastic base housing.
 - d. #10 large head brass terminal and ground screws; back- and side-wired.
- B. Duplex Convenience Receptacles
 1. Duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V.
 2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
 3. Hubbell HBL5362, Pass & Seymour 5362A, or approved equal by acceptable manufacturer.
- C. Weather-Resistant Duplex Convenience Receptacles
 1. Weather-resistant duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:
 - a. "WR" marking on face as required by UL Standard.
 - b. UV-resistant nylon face for longer life under adverse environmental conditions.
 2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498, Federal Specification W-C-596 and 2011 NEC 406.9.
 3. Hubbell HBL5362WR, Pass & Seymour WR5362, or approved equal by acceptable manufacturer.
- D. Duplex USB Charger Receptacles
 1. Decorator style tamper-resistant duplex convenience receptacles shall be heavy-duty, specification grade, 20A, 125V, with the following features:
 - a. 5Vdc output, minimum 3.1 amperes
 - b. Two (2) USB Type "A" ports,
 2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498, UL1310, and Part 15 of FCC regulations.
 3. Comply with battery charging specification USB BC1.2.
 4. Compatible with USB 2.0/3.0 devices, including Apple® products.
 5. Hubbell USB20A5, Pass & Seymour TR5362USB, Hubbell USB20C5, or approved equal by acceptable manufacturer.

E. Dual-Controlled Plug Load Controllable Duplex Receptacles

1. Dual-controlled plug load controllable duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:
 - a. Permanent controlled receptacle marking on each receptacle face, in compliance with 2014 NEC Article 410.6(E), CA Title 24, and ASHRAE Energy Efficiency Standard 90.1.
2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
3. Hubbell HBL5362C2, Pass & Seymour 5362CD Series, or approved equal by acceptable manufacturer.

F. Single Convenience Receptacles

1. Single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V.
2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
3. Hubbell HBL5361, Pass & Seymour 5361, or approved equal by acceptable manufacturer.

G. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.3. GFCI RECEPTACLES

A. General Requirements

1. GFCI receptacles shall have the following basic features:
 - a. Solid-state ground-fault sensing and signaling.
 - b. Trip time of 0.025 seconds (nominal).
 - c. Trip threshold of +/- 5mA.
 - d. Indicator light that is lighted when device is tripped.
 - e. Auto-ground clip to assure positive ground.
 - f. Impact-resistant nylon face and thermoplastic base housing.
 - g. #10 large head brass terminal and ground screws; back- and side-wired.
2. GFCI receptacles shall also have the following functions to comply with UL standard 943:
 - a. An auto-monitoring function that will allow for periodic automatic testing (self-test) of the GFCI device and its ability to respond to a ground fault. If a problem is detected one or more of the following will happen:

- i. Power will be denied (trip with the inability to reset).
- ii. Trip with the ability to reset, subject to the next auto-monitoring test cycle or repeatedly trip.
- iii. Visual and/or audible indication
- b. Provisions to ensure that receptacle type GFCIs that contain separate line and load terminals, and that is powered through its load terminals, shall not reset and supply power to its receptacle face or line terminals if miswired. This applies both during its initial installation and after reinstallation following a correctly wired installation. If the device is provided with special instructions for removal and reinstallation, the instructions shall be followed during testing.

B. Duplex GFCI Receptacles

1. Duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V.
2. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
3. Hubbell GFRST20, Pass & Seymour 2097, or approved equal by acceptable manufacturer.

C. Weather-Resistant Duplex GFCI Receptacles

1. Weather-resistant duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V with the following features:
 - a. "WR" marking on face as required by UL Standard.
 - b. UV-resistant nylon face for longer life under adverse environmental conditions.
2. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
3. Hubbell GFWRST20, Pass & Seymour 2095/7TRWR, or approved equal by acceptable manufacturer.

2.4. LOCKING RECEPTACLES

A. Single Convenience Receptacles

1. Single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD1, NEMA WD6 configuration L5-20R, UL 498 and Federal Specification W-C-596.

B. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.5. SWITCHES

A. General Requirements

1. Switches shall have the following basic features:
 - a. Heavy-gauge one-piece copper alloy contact arm.
 - b. Fast "make" and positive "break" to minimize arcing.
 - c. Heavy-duty bumper pads for quiet operation.
 - d. High strength thermoplastic polycarbonate toggle.
 - e. Oversized silvery alloy contacts for long life and heat dissipation.
 - f. Nickel-plated steel strap with integral ground.
 - g. Auto-ground clip to assure positive ground.

B. Toggle Switches

1. Toggle switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A: Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
2. Hubbell HBL1221 (single-pole), HBL1222 (two-pole), HBL1223 (three-way), HBL1224 (four-way), Pass & Seymour PS20AC1 (single-pole), PS20AC2 (two-pole), PS20AC3 (three-way), PS20AC4 (four-way), or approved equal by acceptable manufacturer.

C. Decorator Switches

1. Decorator switches shall be quiet-type, heavy-duty, specification grade, 120/277V, 20A, with cushioned thermoplastic paddle.
2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
3. Hubbell DS120 (single-pole), DS220 (two-pole), DS320 (three-way), DS420 (four-way), Pass & Seymour 2621 (single-pole), 2622 (two-pole), 2623 (three-way), 2624 (four-way), or approved equal by acceptable manufacturer.

D. Illuminated Toggle Switches (Light On with Load Off)

1. Illuminated toggle switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A, with clear illuminated toggle, lighted with load off.
2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
3. Hubbell HBL1221ILC (single-pole), HBL1223ILC (three-way), Pass & Seymour PS20AC1-CSL (single-pole), PS20AC3-CSL (three-way), or approved equal by acceptable manufacturer.

E. Pilot Lighted Switches (Light On with Load On)

1. Pilot lighted switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A, with red illuminated toggle, lighted with load on.

2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
 3. Hubbell HBL1221PL (single-pole), HBL1222PL (two-pole), HBL1223PL (three-way), Pass & Seymour PS20AC1RPL (single-pole), PS20AC2RPL (two-pole), PS20AC3RPL (three-way), or approved equal by acceptable manufacturer.
- F. Lockable Switch Handle Guards
1. Provide handle guards with provisions for padlocking at all toggle switches serving as disconnecting means and where indicated on the Drawings.
 2. Handle guards shall be steel construction, and shall mount directly over standard switch faceplates.
 3. Provide Square D Class 2510 FL1, or approved equal by listed manufacturer.

2.6. WALL-BOX OCCUPANCY SENSOR SWITCHES

- A. Product numbers for Watt Stopper are as follows:
1. Single Relay: DSW 100
 2. Dual Relay: DSW 200
- B. Wall switch sensors shall be capable of detection of motion at desk-top level up to 300 square feet, and gross motion up to 1,000 square feet.
- C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180 degree coverage capability.
- D. Sensors shall be dual technology type using a combination of passive-infrared and ultrasonic detection method to distinguish between occupied and unoccupied conditions for area covered.
- E. Sensors shall feature built-in light level sensing for field-adjustable ambient light override.
- F. All sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.
- G. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioning or heating fans.
- H. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.
- I. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005 percent tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
- J. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working.

- K. All sensors shall have no leakage current to load, in manual or in Auto/Off Mode, for safety purposes and shall have voltage drop protection.
- L. All sensors shall have UL rated, 94V-0 plastic enclosures.
- M. All sensors located in damp/wet locations and dry indoor locations subject to high humidity (i.e. Shower Rooms) shall be suitable for low temperature (down to -40F/-20oC) and high humidity, and shall be corrosion resistant to moisture.
- N. Sensor finishes shall match finish of toggle switches as specified herein.

2.7. FINISHES

- A. Wiring device catalog numbers in Section text do not designate device color. Device colors shall be as follows, unless otherwise indicated elsewhere in the Specifications and Drawings or as required by NFPA or device listing:
 - 1. Wiring Devices connected to Normal Power System: White.
 - 2. Wiring Devices connected to Computer Power System: Gray.
 - 3. Special Receptacles: Black.

2.8. DEVICE PLATES

- A. Device plates shall be provided for all switches and receptacles. Device plates shall be as manufactured to fit each type of single device, to fit devices which are ganged together, and they shall be same manufacturer as wiring devices with finish as follows:
 - 1. Material for Unfinished Spaces: Galvanized steel, unless otherwise noted.
 - 2. Material for Finished Spaces: 0.04-inch-thick, Type 302, satin-finished stainless steel, except as otherwise indicated.
 - 3. Color: Matches wiring device, except as otherwise indicated.
 - 4. Plate-Securing Screws: Metal with heads colored to match plate finish.
- B. Device plates shall be factory engraved to clearly identify receptacles on GFCI-protected circuits. Lettering shall be ¼" high, filled with black paint and read "GFCI".
- C. Covers for Receptacles and Switches in Damp Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lid, listed and labeled for use in "damp locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers shall be self-closing per UL514C42.3, be equipped with stainless steel springs, and shall have a cam action latch for secure closure. Covers for receptacles shall comply with NEC Article 406.9(A). Covers for switches shall comply with NEC Article 404.4.
 - 1. Horizontal Receptacles - Pass & Seymour Model No. CA26H or approved equal by Hubbell, Intermatic or other listed manufacturer.

2. Vertical Receptacles – Pass & Seymour Model No. CA26V, or approved equal by Hubbell, Intermatic, or other listed manufacturer.
 3. Toggle Switches – Pass and Seymour Model No. CA1, or approved equal.
- D. Covers for Receptacles in Damp and Wet Locations: Heavy-duty die-cast zinc/aluminum construction with hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled “extra duty” for use in “wet locations”. All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers shall comply with NEC Article 406.9(B).
1. Duplex/GFCI Receptacles – Pass & Seymour Model No. WIUCAST1 or approved equal by Hubbell, Intermatic, or other listed manufacturer.
- E. Covers for Switches in Damp and Wet Locations: Heavy-duty die-cast zinc/aluminum construction with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Article 404.4 and shall be UL listed for use in wet locations.
1. Toggle Switches – Crouse –Hinds Model No. DS185, or approved equal.

2.9. 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.
- B. Body: Nylon with screw open cable gripping jaws and provision for attaching external cable grip.
- C. 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.

2.10. 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. 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.

2.11. RETRACTABLE CORD REEL WITH SINGLE RECEPTACLE OUTLET

- A. Description: Factory-fabricated retractable cord reel with receptacle connector body and the following features:
 1. Cord: Type “SO” or “SJOOW” cord with conductors to match requirements (voltage, ampacity, quantity) of equipment being connected.

2. Receptacle connector body: Nylon body with integral cable clamping jaws and blade configuration to match equipment being connected.
3. Steel Cast aluminum frame and steel reel side.
4. Factory-assembled, modular type collector ring and brush block assembly.
5. Lifetime lubricated bearings.
6. Removable cover(s) for access to springs and ring/brush assembly.
7. Adjustable, four-roller cord outlet guide.
8. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.

2.12. RETRACTABLE CORD REEL WITH OUTLET BOX WITH GFCI RECEPTACLE

- A. Description: Factory-fabricated retractable cord reel with duplex outlet box with GFCI receptacle and the following features:
1. Cord: Type “SO” or “SJOOW” cord with (3) 12 AWG conductors.
 2. Receptacle outlet: Single-gang FS outlet box with 20 amp, 125 volt, NEMA 5-20R GFCI type duplex receptacle, with weatherproof cover.
 3. Cast aluminum frame and steel reel sides.
 4. Factory-assembled, modular type collector ring and brush block assembly.
 5. Lifetime lubricated bearings.
 6. Removable cover(s) for access to springs and ring/brush assembly.
 7. Adjustable, four-roller cord outlet guide.
 8. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.

2.13. EMERGENCY PUSHBUTTONS

- A. General:
1. Emergency pushbuttons shall be Stopper Station with Mini Stopper cover, as manufactured by Safety Technology International, Inc. (STI), or approved equal.
- B. Features:
1. Button activation shall be Push-to-Activate, Turn-to-Reset.
 2. Interchangeable or replaceable Normally Open (N.O.) or Normally Closed (N.C.), Single-Pole, Single-Throw (SPST) gold-plated contact blocks rated for three (3)

amps at 600 VAC or one (1) amp at 250VDC.

3. Pushbuttons shall include one N.O. and one N.C. contact, unless otherwise indicated on the Contract Drawings.
4. Pushbuttons shall hold up to three (3) sets of isolated contacts.

C. Construction:

1. Housing shall be molded of polycarbonate rated for temperature range of -40 degrees to 250 degrees Fahrenheit.
2. Housing color shall be yellow, unless otherwise indicated.
3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.

D. Labeling:

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:
 - a. "Emergency Power Off"
 - b. "Water Heater Shut-Down"
 - c. "Boiler Shut-Down"

E. Cover

1. Pushbutton covers shall have the following features:
 - a. Molded from thick clear polycarbonate material.
 - b. UV stabilized.
 - c. 94V-2 flammability rating.
 - d. Stainless steel torsion spring to maintain cover in a closed position.
 - e. Mounting hardware and gasket.

F. Quality Assurance

1. Pushbuttons shall be tested and approved or listed by:
 - a. Underwriter Laboratories (UL) and Canadian Underwriter Laboratories No. S7255.
 - b. Complies with UL 2017.
 - c. UL listed for indoor and outdoor use, when used with appropriate weather cover.
2. Pushbuttons shall be ADA Compliant.

G. Warranty

1. Pushbuttons shall be provided with lifetime guarantee against breakage of polycarbonate in normal use.

2. Pushbuttons shall be provided with one year guarantee on electro-mechanical and electronic components.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Verification of existing conditions before starting work.
- B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
 1. Verify that outlet boxes are installed at proper height.
 2. Verify that wall openings are neatly cut and will be completely covered by wall plates.
 3. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- C. By beginning Work, accepts conditions and assume responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2. INSTALLATION – GENERAL

- A. Install devices and assemblies plumb, level, and secure.
- B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top or as required by the local Authority Having Jurisdiction. Exception: Mount exterior GFCI weatherproof duplex receptacles horizontally with grounding terminals on the left, or as required by the local Authority Having Jurisdiction. Group adjacent switches under single, multi-gang wall plates.
- C. Install wall plates when painting is complete.
- D. Protect devices and assemblies during painting.
- E. Coordinate cord and plug connected equipment for type and ratings required.

3.3. INSTALLATION – RECEPTACLES

- A. All 15 ampere and 20 ampere, 125 volt and 250 volt, non-locking type receptacles installed in damp or wet locations shall be listed weather-resistant type in accordance with NEC Article 406.9(A) and 406.9(B) and shall be installed within an enclosure that is weather proof when an attachment plug is inserted.
- B. All 15 ampere and 20 ampere, 125 volt, single-phase, non-locking type receptacles installed in the following locations shall have GFCI protection for personnel, in accordance with NEC Article 210.8(B).
 1. Bathrooms/Toilet Rooms

2. Rooftops
 3. Outdoors
 4. Within six (6) feet (1.8m) of sinks, plumbing fixtures and water piping.
 5. Indoor wet locations.
 6. Mechanical rooms, electrical rooms, garages, service bays, and similar areas where electrical hand tools or portable lighting equipment are to be used.
- C. Where multiple receptacles are indicated on the Contract Drawings as GFCI type receptacles, each device must be a GFCI type receptacle. Protecting standard receptacles downstream from one GFCI receptacle is not acceptable.

3.4. INSTALLATION – SWITCHES

- A. Emergency shut-down push-buttons for gas-fired equipment shall be provided at all means of egress from rooms in which gas-fired equipment is installed.
- B. Switches shall be located as indicated on the drawings, arranged singular or in gangs within 18" of the door jamb on the strike side of the door openings. Verify the door swings with the Architectural Drawings prior to rough-in.
- C. All switches in Mechanical Rooms, Electrical Rooms and other such places shall be a lighted handle, single-pole light switch(es).

3.5. INSTALLATION – OCCUPANCY SENSORS

- A. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations.
- B. The following areas shall have one hundred (100%) percent coverage for minor (small resolution) motion:
 1. Teacher's desks
 2. Desks in office areas
- C. Arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.
- D. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. Provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the occupancy-sensing devices and systems.
 1. Sensors installed in damp locations such as near showers, in wet locations, or where exposed to rain shall be equipped with watertight/weatherproof enclosure.

2. Mounting of passive infrared and dual technology sensors where columns, doors, walls, or other obstructions will block the sensor's field of view should be avoided.
 3. Passive infrared coverage should not extend through doorways. Masking inserts shall be installed for PIR coverage rejection to prevent false tripping.
- E. Install system components in accordance with Manufacturer's instructions. Sensor locations are approximate and are designed according to the specified manufacturer.
- F. Sensors shall be positioned so that lights are activated when a person is 2 feet or less through any doorway.
- G. Prior to energizing circuits, wiring shall be tested for electrical continuity and short circuits to ensure proper polarity of connections is maintained.

3.6. IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification".
1. Switches: Switches shall be labeled as to lights/load controlled and with circuit number and panel identification.
 2. Receptacles: All device plates shall be labeled to identify panelboard and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on face of plate and durable wire markers or tags within outlet boxes. Labels shall be clear with black lettering. Protect label from damage during construction. Replace all damaged and unclear labels.
 3. Pre-wired workstations are also required to have each receptacle labeled to identify the panelboard and circuit number from which it is served.
 4. Mark all conductors with the panel and circuit number serving the device at the device.
 5. Mark the panel and circuit number serving the device on the back side of the device plate with a permanent marking system, machine-generated, that does not show through the front of the plate.
 6. Faceplate labels shall be installed such that they are readable and do not cover any portion of the faceplate securing screw(s) or the wiring device itself.

3.7. CONNECTIONS

- A. Connect wiring device grounding terminal to outlet box with bonding jumper.
- B. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- C. Tighten electrical connectors and terminals according to manufacturers published torque tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.8. FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity, continuity, short circuits, and ground continuity. Operate each device at least six times.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.9. CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

SECTION 262813 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. Fuses.
 - 2. Spare Fuse Cabinets.
- B. The Electrical Contractor shall provide a complete set of fuses for all fusible equipment on the project as indicated on the Contract Documents. Final test and inspections shall be made prior to energizing the equipment.

1.3. PERFORMANCE REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire, cable, bus structures, and other equipment. Provide system to ensure that component damage is within acceptable levels during a fault.
- B. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Provide system to ensure that device closest to fault operates.

1.4. SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for each fuse type specified. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for fuses with current-limiting characteristics
 - 3. Coordination charts and tables and related data.
- C. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.
- D. Provide a complete short circuit coordination study report required to select fuses to protect equipment. Refer to Division 26 Section "Electrical Systems Analysis" for additional information.

1.5. QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from one source and by a single manufacturer.
- B. Comply with NFPA 70 for components and installation.
- C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.
 - 1. The terms Listed and Labeled as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
 - 3. Comply with National Electrical Manufacturer's Association NEMA FU-1 Low Voltage Cartridge Fuses.
 - 4. Comply with IEC269.
 - 5. Comply with CANENA Standard 248.
 - 6. Comply with UL 198.

1.6. EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Spare Fuses: Furnish quantity equal to 20 percent of each 600 ampere and smaller fuse type and size installed, but not less than one (1) set of three (3) of each type and size. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)
 - 2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries Inc. Bussmann Div.
 - 2. Eagle Electric Mfg, Co. Inc.
 - 3. General Electric Co; Wiring Devices Div.
 - 4. Mersen (formerly Ferraz Shawmut)
 - 5. Tracor, Inc; Littelfuse, Inc. Subsidiary
- B. All fuses shall be of the same manufacturer to assure coordination.

2.2. CARTRIDGE FUSES

- A. Characteristics: NEMA FU-1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.
- B. Fuses shall feature a solid state visual open fuse indicator, metal-embossed date and catalog number for identification.

2.3. SPARE FUSE CABINETS

- A. Description: Wall-mounted, locking utility cabinet(s) with shelves for spare fuses.
- B. Construction: 16 or 14 gauge steel, ANSI 61 gray polyester powder paint finish inside and out.
- C. Features:
 - 1. Four mounting keyholes in back of enclosure
 - 2. Removable door with reversible hinge; door can hinge from either left or right side and can be changed without tools
 - 3. Door has quarter-turn key lock; two keys included
 - 4. Retractable spring hinge
 - 5. Three solid shelves.
- D. Dimensions: Cabinet shall be of proper size for orderly storage of spare fuses and fuse pullers stored in the same, plus space for 15 percent spare capacity. Cabinet(s) shall be no smaller than 24"H x 24"W x 12"D.
- E. Fuse Pullers: Provide one (1) fuse puller for each size and type fuse stored in each spare fuse cabinet.
- F. Basis of Design: Provide shelf style locking utility cabinets as manufactured by Hoffman/Pentair, or approved equal by Cooper/Bussman.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. FUSE APPLICATIONS

- A. Main Service and Feeders: Class J, time delay, 600Volt, 0-600 Amp, and 300 kA interrupting rating. Time-delay fuses shall hold 500 percent of rated current for a minimum of 10 seconds and shall be UL listed.

- B. Motor Branch Circuits: Class RK1, time delay, 250 Volt Class J, Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating. Time delay fuses shall hold 500% of rated current for a minimum of 10 seconds.
1. The following guidelines apply for motors protected by properly sized overload relays:
 - a. Fuses for motors with a marked service factor not less than 1.15 shall be installed in ratings of 125% of motor full-load current (or next size larger if 125 percent does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuses may be 150 percent to 175 percent of the motor full-load current.
 - b. For all other motors, (such as 1.0 service factor motors) fuses shall be sized in ratings of 115 percent of the motor full load current (or next size larger if 115 percent does not correspond to a fuse size) except as noted above.
 2. The following guidelines apply where fuses are used as the only overload protection for the motor:
 - a. For motors with a 1.15 service factor or more, fuses should be sized at 125 percent of motor full-load current (or next size smaller if 125 percent does not correspond to a fuse size).
 - b. For all other motors, fuses should be sized at 115 percent of motor full-load current (or next size smaller, if 115 percent does not correspond to a fuse size).
 3. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.
- C. Other Branch Circuits: Class RK1, non time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.
- D. Control Circuits: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.
- E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.
- F. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.
- G. Motor Controllers: NEMA and IEC Style motor controllers shall be protected from short-circuits by Dual-Element Time-Delay fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides no damage protection for the controller, under low and high level fault conditions, as required by IEC Publication 947-4. For IEC style controller, the fuses shall be installed in ratings to coordinate with the overload relays, such that the relay/fuse curves cross over at 7-10 times the IEC contactor current rating.
- H. Panelboards,: The manufacturer shall supply equipment utilizing fully-rated and listed

components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3. INSTALLATION

- A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.
- B. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings and open fuse indicator are visible without removing fuse.
- C. Installation: Provide one (1) locking fuse cabinet in the mechanical room. Cabinet(s) shall be mounted 5'-6" to top unless otherwise noted on the Contract Drawings.
- D. Provide fuse clips as required.

3.4. IDENTIFICATION

- A. Identification: Provide engraved nameplate to read "SPARE FUSES" in 1/2" high lettering on front door of cabinet(s). Refer to Division 26 Section, "Electrical Identification" for nameplate requirements.

END OF SECTION

SECTION 262816 – DISCONNECT SWITCHES & CIRCUIT BREAKERS

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 individually mounted disconnect switches and circuit breakers used for the following:
 - 1. Service disconnect switches.
 - 2. Equipment disconnect switches.
 - 3. Feeder disconnect switches.
 - 4. Motor disconnect switches.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Section, “Wiring Devices” for toggle switches used as disconnecting means.
 - 2. Division 26 Section, “Fuses” for fuses in fusible disconnect switches.
- C. Provide method of disconnection at all appliances, motors, equipment, etc., as required to comply with NEC (including Article 422-C, and Article 440-D).

1.3. SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section. Include the following:
 - 1. Descriptive data and time current curves.
- C. Coordination charts and tables and related data.
- D. Submit a schedule of equipment to indicate ratings of disconnects, fuses, circuit breakers, and other electrical characteristics for each item of equipment.
- E. Maintenance data for disconnect switches and circuit breakers to include in the operation

and maintenance manual specified in Division 01.

F. Field test reports indicating and interpreting test results.

1.4. QUALITY ASSURANCE

A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

3. Underwriters Laboratories (UL) listed equipment: UL 98 - Enclosed and Dead Front Switches, UL 50 - Cabinets and Boxes, UL489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures, NEMA 250 - Enclosures for Electrical Equipment.

4. Comply with ANSI and NEMA Standards for materials ratings.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide equipment from one of the following manufacturers; no other manufacturers are acceptable.

1. Disconnect/Safety Switches:

- a. Square D Company. (Basis of Design)
- b. Eaton Corp.; Cutler Hammer.
- c. Siemens Energy & Automation, Inc.
- d. General Electric (GE)

2. Enclosed Circuit Breakers:

- a. Square D Company. (Basis of Design)
- b. Eaton Corporation; Cutler Hammer.
- c. Siemens Energy & Automation, Inc.
- d. General Electric (GE)

2.2. DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: Heavy duty, NEMA KS 1, Type HD, with lockable handle in the OFF position. Switch shall be provided with an override screw to permit opening

front cover with switch in ON position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

- B. Enclosed, Fusible Switch, 800 A and Smaller: Heavy duty, NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable in the OFF position, with 2 padlocks, and interlocked with cover in CLOSED position. Switch shall be provided with an override screw to permit opening front cover with switch in ON position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.
- C. Characteristics: Size, number of poles and ratings as indicated and to match load being served.
- D. Enclosure: NEMA KS 1, Type 1, with gray baked enamel finish, unless otherwise specified or required to meet environmental conditions of installed location. Enclosure shall be rated for 200,000 rms symmetrical amperes short circuit current.
 - 1. Outdoor Locations: Type 3R, with top-hinged, attached with removable screws.

2.3. ENCLOSED CIRCUIT BREAKERS

- A. Enclosed, Molded Case Circuit Breakers: NEMA AB 1, with lockable handle.
- B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current, minimum of 10,000 symmetrical rms amperes.
- C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air conditioning, and refrigerating equipment.
- D. Circuit Breakers, 250 Ampere Frame and Smaller: Factory sealed thermal magnetic trip units.
- E. Circuit Breakers, 400 Ampere Frame and Larger: Electronic trip units with field adjustable, short time and continuous current settings.
- F. Molded Case Switch: Where indicated, molded case circuit breaker without trip units.
- G. Lugs: Mechanical lugs and power distribution connectors for number, size, and material of conductors indicated.
- H. Shunt Trip: Where indicated. Provide voltage rating as required.
- I. Accessories: As indicated.
- J. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 3R.
- K. Provide full capacity neutral lug or 200 full capacity neutral for non-linear loads and

equipment grounding lug as required.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- B. Install disconnect switches and circuit breakers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.
- C. Install disconnect switches and circuit breakers to have adequate working space in accordance with Article 110.26 of the National Electrical Code. Disconnect switches and circuit breakers shall not be installed beneath ductwork, piping, etc.
- D. Install wiring between disconnect switches, circuit breakers, and associated control and indication devices.
- E. Provide fuses for all fusible safety switches as indicated and required by the load being served. Coordinate fuse ratings with mechanical equipment electrical characteristics.
- F. Provide disconnect switches for all equipment as indicated and as required by the NEC. Where disconnect switches are specified and furnished with mechanical equipment, install one only. Coordinate devices furnished for mechanical equipment with Division 23 Drawings and Specifications.
- G. Weatherproof enclosures shall be provided for all disconnect switches and circuit breakers exposed to the elements whether called for or not.
- H. Disconnect Switches and circuit breakers shall be labeled for service entrance use, if so required, where used for service entrance whether called for or not.
- I. Disconnect Switches and circuit breakers provided shall be suitable for:
 - 1. Circuit application voltage.
 - 2. Circuit application ampacity x 125 percent.
 - 3. One pole, two pole, three pole, solid neutral, ground connection, all as required by item served or as shown on the drawings.
- J. Install disconnect switches and circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's Standard of Installation, and in accordance with recognized industry practices.

3.2. CONNECTIONS

- A. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
- B. Tighten electrical connectors and terminals according to manufacturers' published torque

tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3. IDENTIFICATION

- A. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26 Section, "Electrical Identification". All switches shall be provided with engraved nameplates which clearly identify the equipment served, circuit designation, and circuit voltage/phase.
- B. Each disconnect means shall be legibly marked as required by Code (including integral disconnect units furnished with motors, appliances, feeders, and branch(es)).

3.4. FIELD QUALITY CONTROL

- A. Visual and mechanical inspection: Include the following inspections and related work.
 - 1. Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.
 - 2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
 - 3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
 - 4. Check tightness of electrical connections of devices with calibrated torque wrench. Use Manufacturer's recommended torque values.
 - 5. Clean devices using Manufacturer's approved methods and materials.
 - 6. Verify proper fuse types and ratings in fusible devices.
 - 7. Verify that fuses are facing out and that fuse ratings and blown fuse indicators are visible without removing fuses.

3.5. ADJUSTING

- A. Adjust/replace fuses in disconnect switches if required to properly coordinate with overcurrent protection requirements of equipment served and with upstream and downstream protective devices.
- B. Set field adjustable circuit breaker trip ranges as recommended in overcurrent protection coordination study specified in Division 26 Section, "Electrical Systems Analysis".

3.6. CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including

chips, scratches, and abrasions.

END OF SECTION

SECTION 262913 - MOTOR 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 motor-control devices rated 600 V and less that are supplied as enclosed units.
- B. Related Sections include the following:
 - 1. Division 26 Section "Common Work Results for Electrical" for Mechanical - Electrical coordination requirements.
 - 2. Division 26 Section "Common Work Results for Electrical" for general materials and installation methods.
 - 3. Division 26 Section "Electrical Identification" for labeling materials.
 - 4. Division 26 Section "Fuses" for fuses installed in combination magnetic motor controllers with fusible disconnect switches.

1.3. DEFINITIONS

- A. CPT: Control power transformer.
- B. N.C.: Normally closed.
- C. N.O.: Normally open.
- D. OCPD: Overcurrent protective device.

1.4. SUBMITTALS

- A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For products to include in the operation and maintenance manuals specified in Division 01.
- D. 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.

- E. Submit a schedule of equipment to indicate motor controller ratings, sizes, and other electrical characteristics for each item of equipment.

1.5. QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 50 miles (80 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.
- C. Comply with NFPA 70.
- D. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.
- E. UL Compliance: NEMA ICS 2, Industrial Control Devices, Controllers and Assemblies.

1.6. 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 temporary electric heating, with at least 250 W per controller.

1.7. PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.8. COORDINATION

- A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the

duty cycle of the motor and load.

- C. The horsepower rating of all starters shall be checked against actual motor to be controlled, before installation and correct size overload elements shall be provided in all starters based on nameplate and manufacturer's recommendation.
- D. Provide all control devices and wiring, where not provided under Division 23, required for all equipment.
- E. Motors and controllers shall be provided for voltage and current characteristics as indicated. In the event that equipment provided is of different electrical characteristics than the ones specified, any increase in electrical feeders, conduits, circuit breakers, etc., including increase of labor cost shall be the responsibility of the Contractor.
- F. Provide branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible metal conduit (FMC) in dry locations and with Liquid-Tight Flexible Metal Conduit (LFMC) in damp/wet locations.
- G. All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.
- H. Power Branch Circuits: Wire sizes for branch circuits not specifically called for on drawings or in Specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

1.9. 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. Fuses for Fusible Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Overload Relays: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Pilot Lights: Equal to 10 percent of quantity installed for each type, but no fewer than two of each type. Where lamps are field replaceable, furnish spare lamps only.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers. No other manufacturers are acceptable.
 - 1. Square D Company; Groupe Schneider. (Basis of Design).
 - 2. Eaton Corporation; Westinghouse & Cutler-Hammer Products.
 - 3. Siemens Energy and Automation, Inc.
 - 4. Allen-Bradley Company; Industrial Control Group.
 - 5. Crouse-Hinds ECM; Cooper Industries, Inc. Division.
 - 6. General Electric (GE).
- B. All motor controllers shall be NEMA type controllers. IEC type controllers shall NOT be acceptable.

2.2. MANUAL MOTOR CONTROLLERS

- A. Description: NEMA ICS 2, AC general-purpose Class A manually-operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit. Manual motor controllers shall be equipped with red pilot light, hand-off-automatic selector switch and toggle operator. Provide size and number of poles as required for a complete installation of the equipment being connected. Coordinate voltage of pilot light with voltage/phase of circuit serving equipment.
- B. Thermal Overload Units:
 - 1. Thermal overload units shall be melting alloy type, properly sized for the equipment being protected, and shall be interchangeable. Controller shall be inoperable if thermal overload unit is removed.
- C. Enclosure: ANSI/NEMA ICS 6; Type 1 for interior use and Type 4 water-tight and dust tight die-cast zinc for damp/wet locations. Provide flush-mounted enclosures for units located in finished areas. Provide handle guard with locking provisions in the "off" position on all enclosures.
- D. Furnish Square D, Class 2510 Type F motor controllers with 2510 FL1 handle guard, or approved equal.

2.3. MANUAL MOTOR SWITCHES

- A. Description: NEMA ICS 2, AC general-purpose Class A manually-operated, full-voltage controller for integral horsepower induction motors, without thermal overload unit. Manual motor switches shall be equipped with red pilot light and toggle operator. Provide size and number of poles as required for a complete installation of the equipment being connected. Coordinate voltage of pilot light with voltage/phase of circuit serving equipment.

- B. Enclosure: ANSI/NEMA ICS 6; Type 1 for interior use and Type 4 water-tight and dust tight die-cast zinc for damp/wet locations. Provide flush-mounted enclosures for units located in finished areas. Provide handle guard with locking provisions in the "off" position on all enclosures.
- C. Furnish Square D, Class 2510 Type K motor controllers with 2510 FL1 handle guard, or approved equal.

2.4. COMBINATION MAGNETIC MOTOR CONTROLLERS

- A. Description: Combine magnetic motor controllers with fusible switch disconnect in common enclosure.
 - 1. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A full-voltage, non-reversing, across-the-line magnetic controller for induction motors rated in horsepower.
 - 2. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle and visible blades. Switch shall have a color-coded externally operated handle. Operating handle shall give positive visual indication of "on/off" with red and black color-coding. Switch shall have fuse clips to accept rejection-type, dual-element, current-limiting, time-delay fuses, as specified in Division 26 Section "Fuses".
- B. Control Circuit: Coordinate with Automatic Temperature Control Contractor; obtained from integral control power transformer.
- C. Coil: Encapsulated type.
- D. Poles: As indicated.
- E. Size: NEMA size 1, unless otherwise indicated.
- F. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.
- G. Wiring: Straight-through wiring with all terminals clearly marked.
- H. Overload Relay: NEMA ICS. Provide with sensors in each phase matched to nameplate full-load current of specific motor to which they connect, and with appropriate adjustment.
 - 1. Solid State: Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. It shall be available in Trip Class 10 or Class 20 and have a mechanical test function.
 - 2. Outputs: Provide normally closed (N.C.) auxiliary contact.
 - 3. Reset: Unit shall offer both manual reset and remote reset using an external module.

- I. Options and Features:
1. Control Power Transformers: Include a control power transformer with adequate capacity to operate connected pilot light, indicating and control devices, plus 100 percent spare capacity. Provide fused secondary protection and bond un-fused leg of secondary to enclosure.
 2. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts in each starter in addition to the standard normally open (N.O.) sealing contact.
 3. Selector Switches: Rotary type, Hand-Off-Automatic (H-O-A) selector switch. All switch positions shall be maintained contact.
 4. Cover Mounted Indicating Lights: Green "Power Available" and red "Running" LED type indicating lights. "Power Available" indicating light shall be connected at the load side of the fused secondary terminals of the control power transformer. "Running" indicating light shall be connected through one normally open (N.O.) auxiliary control contact. Indicating lights connected to the start button or across the load side of starters will not be acceptable. Indicating lights shall be equipped with individual legend plates supplied by the manufacturer.
 5. Pilot Device Contacts: NEMA ICS 2, Form "Z".
- J. Furnish Square D, Class 8538 Type S, or approved equal.

2.5. ENCLOSURES

- A. Description: All motor controllers shall be mounted in enclosures, flush or surface mounted as required. Provide flush-mounted enclosures for motor controls in finished locations.
- B. Enclosures shall comply with requirements of NEMA 250 – “Enclosures for Electrical Equipment”, and NEMA ICS 6 – “Enclosures Standard”.
- C. Enclosures shall be provided in accordance with the following requirements in order to meet environmental conditions at the installed location of each motor controller.
1. Dry, Interior Locations: NEMA Type 1.
 2. Damp or Wet Outdoor Locations: NEMA Type 3R.

PART 3. EXECUTION

3.1. APPLICATIONS

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Use fractional-horsepower manual motor controllers for single-phase motors, unless

otherwise indicated.

- D. Hand-Off-Automatic Selector Switches: In covers of motor controllers started and stopped by automatic controls or interlocked with other equipment.
- E. Provide heaters and/or fuses correlated with full load nameplate current of motors provided. Set adjustable overload devices to suit motor provided.

3.2. INSTALLATION

- A. Install motor controllers in locations as indicated, according to manufacturer's written instructions.
- B. Install motor controllers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.
- C. Install motor controllers to have adequate working space in accordance with Article 110.26 of the National Electrical Code. Motor controllers shall not be installed beneath ductwork, piping, etc.
- D. Install independently mounted motor-control devices according to manufacturer's written instructions.
- E. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.
- F. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 26 Section "Hangers and Supports".

3.3. IDENTIFICATION

- A. Identify motor-control components and control wiring according to requirements specified in Division 26 Section "Electrical Identification".
- B. All motor controllers shall be provided with engraved nameplates which clearly identify the equipment served, circuit designation, and circuit voltage/phase.

3.4. CONTROL WIRING INSTALLATION

- A. Install wiring between motor-control devices according to Division 26 Section "Conductors and Cables".
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic control devices where available.

3.5. CONNECTIONS

- A. Connect motor controllers and components to wiring system and to ground as indicated and instructed by manufacturer.
- B. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected

connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6. FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Include the following inspections and related work.
1. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with drawings and schedules.
 2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
 3. Check tightness of electrical connections of devices with calibrated torque wrench. Use Manufacturer's recommended torque values.
 4. Clean devices using Manufacturer's approved methods and materials.
 5. Verify proper fuse types and ratings in fusible devices.
 6. Verify that fuses are facing out and that fuse ratings are readable without removing fuses.
 7. Verify proper overload types and ratings in devices with overload protection.
 8. Verify proper operation of pilot lights.
 9. Verify proper operation of hand-off-automatic selector switches.
 10. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.

3.7. CLEANING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.8. DEMONSTRATION

- A. Training: Engage a factory-authorized service representative to demonstrate motor controllers and train Owner's maintenance personnel.
1. Conduct a minimum of 4 hours of training in operation and maintenance as specified in Division 01 Section "Contract Closeout". Include training relating to equipment operation and maintenance procedures.

2. Schedule training with at least 7 days' advance notice.

END OF SECTION

SECTION 265100 - 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 interior lighting fixtures, lamps, ballasts, emergency lighting units, and accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control System" for programmable lighting control systems.
 - 2. Division 26 Section "Lighting Control Devices" for time clocks, outdoor photoelectric relays, and multi-pole contactors.
- C. Provide a lighting fixture for each fixture shown on the Drawings as described in this Specification, of the design and quality indicated herein. Provide fixtures complete, including lamps of the wattage and type indicated.
- D. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this contract shall be furnished by the Contractor.
- E. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.
- F. Specifications and scale Drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
- G. Minor details, not usually indicated on the Drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.
- H. Omissions: The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this Specification rests with the Contractor.

1.3. SUBMITTALS

- A. Product Data: Submit fixture shop drawings in booklet form with separate sheet for each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.
 2. Certified results of independent laboratory test for fixtures and lamps for electrical ratings and photometric data. Test data shall include manufacturer and model number for fixture being submitted.
 3. Electronic LED Drivers.
 4. Light Sources.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.
- C. Samples for Verification: For lighting fixtures requested for sample submission by the Owner and/or Architect/Engineer. Refer to paragraph "Samples", in this Section, for additional information.
1. Lamps: Specified units installed.
 2. Ballast: 120-V model of specified ballast type.
 3. Accessories: Cord and plug.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Record Documents: Accurately record actual location of each luminaire with the associated switching/control arrangement.
- F. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 01. Include technical data sheets and parts ordering information. Include testing and maintenance requirements and instructions for emergency lighting equipment.
- G. Lighting Calculations: Submit point-by-point lighting calculations for spaces where fixtures being submitted are not listed on the Interior Lighting Fixture Schedule on the Contract Drawings. All calculations shall strictly conform to IES Standards.

1.4. QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction. Provide only UL listed and labeled fixtures with UL listed wiring. Wiring shall be suitable for the fixture temperature listing.
- B. Comply with NFPA 70.
- C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

- D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- E. Mockups: Provide lighting fixtures for room or module mockups where required by the Architect. Install fixtures for mockups with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Remove mockups when directed. Fixtures may be reinstalled in the Work with approval of Architect.
 - 4. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. UL Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. (Standards for Safety), and others as they may be applicable. A UL listing shall be provided for each fixture type and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.
- G. Installer: All Installers shall have not less than five (5) years' experience in the installation of lighting fixtures of the type and quality shown.
- H. Materials, equipment and appurtenances, as well as workmanship provided under this Section, shall conform to the highest commercial standard as specified and as indicated on the drawings.
- I. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.
- J. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication Numbers LE1 and LE2 pertaining to lighting equipment and LE4 pertaining to recessed luminaires.
- K. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office building.
- L. UL Compliance: Comply with UL Standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled and comply with the following UL Standards:
 - 1. UL 1598 – Luminaires (Tri-national standard)
 - 2. UL 1993 – Self Ballasted Lamps and Lamp Adapters
 - 3. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products
 - 4. UL 8753/ULC-S8753 – Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines

5. UL 8754/ULC-S8754 – Holders, Bases, and Connectors for Solid-State (LED) Light Engines and Arrays.
 6. UL 935, UL 1029, UL 542 – Ballasts
 7. UL 496 – Lampholders
 8. UL 924 – Emergency Lighting and Power Equipment
- M. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballasts Manufacturer's Association Standards and carries the CBM label.
- N. NECA/IESNA Compliance: Comply with NECA/IESNA 500 – 1998 Standard, Installing Indoor Commercial Lighting Systems (ANSI).

1.5. COORDINATION

- A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction. Provide plaster frames, hangers, trim rings, and fittings, as required for each type of ceiling construction.
- B. The Contractor shall coordinate switch and lighting control devices with door swings and other architectural features.
- C. The Contractor shall be responsible for providing the required quantity of ballasts to provide the control and operations of the lighting fixtures as indicated by the lighting controls on the Drawings. For example, where two switches are indicated to serve fixtures, then two ballasts per fixture shall be provided.

1.6. WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
- C. Special Warranties for Electronic Drivers: Written warranty, executed by manufacturer agreeing to replace ballasts and drivers that fail in materials or workmanship within specified warranty period.
 1. Special Warranty for Electronic Drivers: Five (5) years from date of manufacture, but not less than four years from date of substantial completion.

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. LED Circuit Boards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 - 3. Electronic LED Drivers: 1 for every 20 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. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, the products indicated in this Specification.
 - 1. The suitability of named (basis of design) fixture only has been verified. Alternate fixtures may be submitted for review, but shall be equal to or better in quality and performance to that of named item, and must be suitable for application.
 - 2. By providing other than named fixture, Contractor assumes full responsibility for all necessary adjustments.
 - 3. Data listed and model number shown for each fixture type indicate minimum requirements and no exceptions will be made.

2.2. FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Reflecting Surfaces: 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 Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rhom & Haas, Dupont, or as acceptable. The quality of the raw material must equal or exceed IES, SPI and NEMA Specifications by at least 100%--which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
 2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.
 3. Glass used for lenses, refractors, and diffusers in lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures, use tempered Borosilicate glass, Corning #7740, or as acceptable. For fixtures directly exposed to the elements and aimed above the horizontal with a radiant energy of 4.16 watts per square inch, or greater, use Vycor glass.
 4. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.
 5. Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
 6. Cleaning: All lenses shall be turned over to the Owner clean and free of dust.
- F. Hardware: All hardware (e.g. screws, nuts, washers, latches, etc.) for fixtures located in damp/wet locations shall be stainless steel, unless otherwise indicated on the drawings.

2.3. FINISHES

- A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350 degree Fahrenheit minimum, catalytically or photochemically polymerized after application.
- B. Ceiling opening frames shall either be manufactured of non-ferrous metal, or be suitably rust-proofed after fabrication.
- C. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.
- D. Undercoat: Except for stainless steel, give ferrous metal surfaces a five-stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

- E. Unpainted non-reflecting surfaces shall be satin finished and coated with a stoved clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
- F. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum trims with an anodized coating of not less than 35 mg per square inch or a color and surface finish as selected by the Architect.
- G. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reflectance of not less than 85%.
- H. Fixtures: Manufacturer's standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.
- I. White finishes: Minimum of 85 percent reflectance.

2.4. LED ELECTRONIC DRIVERS

- A. Manufacturers: Provide quality LED electronic drivers by the manufacturers listed below. Off-brand/generic electronic drivers shall not be acceptable.
 - 1. Advance (Philips Lighting Electronics)
 - 2. eldo LED
 - 3. General Electric (GE) Lighting
 - 4. Lutron Electronics, Inc.
 - 5. Osram Sylvania
 - 6. Samsung
 - 7. Universal Lighting Technologies, Inc.
- B. General Requirements:
 - 1. Suitable for operating type and quantity of LED sources indicated at full light output.
 - 2. No PCBs.
 - 3. Suitable for dry and damp locations.
 - 4. Starting temperature: 0 degrees Celsius.
 - 5. 50,000 hour (minimum) design life.

6. Class 2 output UL recognized to UL and CSA requirements.

C. Electrical Requirements:

1. 0-10V dimming standard, 1% minimum unless otherwise noted on the Contract Drawings.
2. Power Factor: 90 percent (0.9) minimum.
3. Total Harmonic Distortion (THD): Less than 20 percent.
4. Sound Rating: A.
5. Short circuit and overload protection standard.
6. Inherent thermal protection standard.

D. Listings:

1. ANSI C62.41: Category A for transient protection.
2. ANSI C82.11
3. FCC Part 15: Non-consumer equipment EMC.
4. UL 1310: Standard for Class 2 Power Units.

E. Warranty:

1. Minimum five-year warranty.

2.5. EMERGENCY BATTERY PACKS

A. Unless otherwise indicated, features include the following:

1. Conform to UL 924 “Emergency Lighting and Power Equipment”
2. Conform to NFPA 101 and International Building Code (IBC) requirements.
3. Initial Light Output: Provide as indicated.
4. Illumination time: 90 minutes, minimum.
5. Battery: Long life, high temperature, maintenance-free Nickel-Cadmium battery with test switch.
6. Self-Testing Diagnostics: Provide as indicated.
7. Cold Weather Operation: Provide as indicated.
8. Warranty: Minimum 5 year full product warranty.

9. Manufacturers: Provide specification grade emergency battery ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.
 - a. Bodine
 - b. Iota
 - c. Power Sentry

2.6. EXIT SIGNS

- A. General Requirements: Comply with UL 924, “Emergency Lighting and Power Equipment”, and the following:
 1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
- B. Internally Lighted Signs: As follows:
 1. Lamps for AC Operation: Light-emitting diodes (LED), 25 + years rated lamp life.

2.7. LED LIGHT SOURCES

- A. Manufacturers: Provide quality LED light sources by the manufacturers listed below, off brand/generic light sources shall not be acceptable.
 1. Cree
 2. Nichia
 3. Osram
 4. Philips
 5. Samsung
- B. Correlated color temperature (CCT): 5,000 as indicated on the Contract Drawings.
- C. Light sources shall have a maximum deviation of 3-step Macadam Ellipses.
- D. Color rendering index (CRI): 80 CRI minimum.
- E. L70 rating shall meet or exceed value indicated on the interior lighting fixture schedule.
- F. Light sources installed in outdoor environments shall be rated for low temperature applications (0°F, minimum).

2.8. FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section “Common Work Results for Electrical” and Division 26 Section “Hangers and Supports”, for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (12-mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

- C. Twin-Stem Hangers: Two, 1/2-inch (12-mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
- D. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.
- G. Recessed fixtures shall be removable from below to allow access to outlet/junction boxes in ceiling spaces.
- H. Each fixture shall be supplied with necessary straps, supports, or hangers, or other miscellaneous materials and devices to install them in a satisfactory manner to conform to architectural treatment and finishes in area in which they are to be installed. Consult all Mechanical, Architectural and Structural Plans and related Contract Documents to be familiar with all necessary details for proper fixture placement. Failure to do so will not relieve the Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.

2.9. FIXTURES

- A. Refer to "Interior Lighting Fixture Schedule" on the Contract Drawings.

PART 3. EXECUTION

3.1. INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Support for Fixtures independent of ceiling systems, ducts, and piping.
 - 1. Install a minimum of two support system rods or wires for each fixture from structure above. Locate not more than 6 inches (150 mm) from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- C. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), 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.
 4. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings. Provide alignment fittings as required for uniform, level installation of continuous rows of suspended fixtures.
- D. Fixture installations with fixtures supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all lighting fixtures adequately, providing extra steel work for the support of fixtures if required. Any components necessary for mounting fixtures shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.
- E. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop drawings.
- F. Support for Recessed and Semi-Recessed Fixtures: Installed units may not be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from the fixture corners.
1. Fixtures Smaller Than Ceiling Grid: Install a minimum of two rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.
 2. Fixtures of Sizes Less than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees.
 3. Recessed fixtures shall be provided with the proper plaster frame or suitable adapter to receive the finished ceiling construction.
 4. Recessed lighting fixtures shall be suitable for the ceiling or wall material and construction in which they will be installed.
 5. Recessed mounted lighting fixtures shall be connected to a junction box with flexible conduit. Final connection to light fixture shall be with heat-resistant wire.
- G. Each lighting fixture shall be rigidly supported from the building construction and shall include suspension hangers, devices, and extra steel work for fixture support where required.
1. Support all lighting fixtures adequately. Special supports shall be installed as required.
 2. Luminaires shall be furnished with all necessary stems, plaster frames, hangers, for the safe support of the fixture. All supports for fixtures shall be adequate to support weight of the fixtures. All visible hanging devices and appurtenances shall have the same finish as the fixture unless specifically indicated otherwise.

- H. Coordinate with the work of other trades to determine modifications required to make fixtures suitable for ceilings as installed and verify the types of ceiling construction prior to fixture fabrication. Determine that the suspension method and the flange arrangement for the fixtures coordinates with the ceiling type and its suspended system. Fixtures which are shipped to the project and do not fit, or which otherwise do not match the ceiling system, shall be returned for correction at no additional cost.
- I. Lamping: Lamp units according to manufacturer's instructions.
- J. Installation shall include receiving, checking, storage in a safe and approved area until they are required for installation, unpacking, assembly of separate fixture components where required, and complete wiring and connection including the provision of associated wiring and connection devices such as fittings, hangers, aligners, box covers, and similar hardware which may be required for certain fixtures, but are not detailed or scheduled with the fixtures.
- K. Plaster frames or mounting frames shall be provided for all fixtures which require them and shall be suitable for the ceiling construction in which they will be installed.
- L. Trim rings shall be painted to match the finish of the adjacent ceiling surface.
- M. Fixtures in equipment rooms shall be positioned clear of equipment interference and yet provide adequate light for working around the equipment.
- N. All lighting fixtures, when installed, shall be set free of light leaks, warps, dents, or other irregularities.
- O. Pendant-type fixtures shall be hung at heights as required, and as shown on the Drawings.
- P. Install all lamps required, including replacements for burned out lamps, until final acceptance of the completed work. No lighting fixture will be installed without lamps.
- Q. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Owner's Representative, who may require that new lamps be installed and fixtures cleaned at the time of turnover to the Owner.
- R. Lighting fixtures for general illumination, emergency lighting, and exterior lighting, shall be complete with all required accessories and attachments.
- S. Fixtures shall bear UL label and shall be wired and installed in full compliance with applicable codes.
- T. The omission of a type or quantity in the Interior Lighting Fixture Schedule on the Contract Drawings shall not relieve the Contractor of the responsibility of installing all required fixtures, of proper type, as shown on the Drawings.
- U. Fixtures shall be recessed, surface, or pendant type, as specified and shall include sockets, diffusers, ceiling canopies and stems, hickeyes, and all other necessary accessories.
- V. Where suspended ceilings with steel channels occur, outlets and fixtures shall be supported

on members resting on the channel framework. In no case shall fixtures be supported from plasterboard, plaster, or acoustic material.

3.2. GENERAL INSTALLATION OF FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's Standard of Installation, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. All recessed fixtures mounted in dry wall or plaster ceilings shall be complete with a suitable plaster frame or trim ring. All fixtures shall be mounted on or in ceilings in accordance with published recommendations of the manufacturers using bar or swing-way hangers, etc. These items shall be furnished as part of the fixture whether called for by catalog number or not.
- C. All fixtures shall be installed in strict accordance with NEC Article 410 and shall properly and suitably support the weight of any fixture installed. All fixtures shall be supported independently of ceiling suspension system being attached to building structure.
- D. Every lighting fixture shall be of the type for the ceiling construction in or on which it is to be installed. It shall be the Electrical Contractor's responsibility to coordinate this with the Ceiling Contractor.
- E. Install surface-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface. Apply small bead of caulk or silicone around perimeter of fixture to conceal gaps between fixture and finished surface.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.3. CONNECTIONS

- A. Ground equipment. 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.

3.4. FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Advance Notice: Give dates and times for field tests.
- C. Provide instruments to make and record test results.
- D. Tests: As follows:
 - 1. Verify normal operation of each fixture after installation.

2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 3. Verify normal transfer to emergency source and retransfer to normal.
 4. Report results in writing.
- E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- F. Corroded Fixtures: Replace during warranty period.

3.5. CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.
- C. Touch up luminaire finish at completion of work.
- D. Replace all lamps that fail within three (3) months of Substantial Completion.
- E. Replacement Lamps: At the time of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed or burned out after Contractor's use and testing. Furnish stock or replacement lamps as specified in this Section, Paragraph "Extra Materials". Deliver replacement stock as directed. Refer to Division 01 Sections for the replacement/restoration of lamps in interior lighting fixtures, and where used, the temporary lighting prior to time of Substantial Completion.

3.6. DEMONSTRATION

- A. Provide a minimum of four (4) hours of training and demonstration of luminaire operations, setting, aiming, adjustment, and maintenance.

END OF SECTION

SECTION 265600 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 exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for lighting fixtures installed on the exterior walls of the building.
 - 2. Division 26 Section "Lighting Control Devices" for time clocks, [additional photoelectric relays,] [and][multi-pole lighting contactors].
 - 3. Division 26 Section "Network Lighting Controls" for programmable lighting control systems controlling exterior lighting.

1.3. DEFINITIONS

- A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.
- B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4. SUBMITTALS

- A. Product Data: Provide dimensioned and detailed drawings in booklet form with separate sheets for each type of lighting unit indicated, arranged in order of lighting unit type and designation. Include data on features, accessories, finishes, and the following:
 - 1. Materials and dimensions of luminaires and poles.
 - 2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data. Include manufacturer and model number of fixture being submitted.
 - 3. Lamp ANSI designation, initial and mean lumen output, average-rated hours of lamp life and lamp mortality curve, and color temperature and color rendering index.
 - 4. Ballast ANSI designation; electrical characteristics, including voltages, lamp and line operating and starting amperes, watts and watt losses, percent of allowable

- line voltage variation range and lamp crest factor; minimum lamp starting temperature; and normal and maximum ballast operating temperature.
5. Ballast CBM approval and UL listing, volts, lamp and input amperes, input watts, and minimum lamp starting temperature.
 6. Poles and standards dimensions, details of hand holes and wire entries, mast or bracket arms and connection to poles, wind load and deflection, and finishes.
- B. Shop Drawings: Anchor bolt templates keyed to specific poles and certified by manufacturer.
 - C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
 - D. Record Documents: Accurately record actual location of each luminaire with the switching arrangements shown.
 - E. Submit pole load calculations, including EPA wind load calculations, for all poles. Calculations shall include all pole-mounted devices including luminaires, call stations, handholes, directional signs, and banners. Refer to this Section, Paragraph "Fixtures" for additional information. Wind resistance calculations shall be certified by a Registered Professional Engineer.
 - F. Submit point by point lighting calculations for layout shown on the Contract Drawings if utilizing lighting fixture(s) other than first-named fixtures in the "Exterior Lighting Fixture Schedule" on the Contract Drawings (Basis of Design). All calculations shall strictly comply with IES Standards. Indicate foot candle readings minimum 5'-0-inches on center along the horizontal plane.
 - G. Maintenance Data: Submit maintenance data and parts list for each exterior lighting fixture and accessory; including trouble-shooting maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with requirements of Division 01.

1.5. QUALITY ASSURANCE

- A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.
- B. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C2, National Electrical Safety Code.
- C. FM Compliance: Units for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.
- D. Comply with recommended practices of Illuminating Engineering Society (IES).
- E. All products shall comply with UL and shall be UL listed.

- F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of exterior building lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- G. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with exterior lighting fixture work similar to that required for the project.
- H. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 25, 250, 410, and 501 as applicable to installation, and construction of lighting fixtures encompassed by this section.
- I. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication No. LE 2 pertaining to lighting equipment.
- J. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
- K. UL Compliance: Comply with requirements of UL Standards, including Standards 486A and B, pertaining to exterior lighting fixtures. Provide exterior lighting fixture and components which are UL listed and labeled and comply with the following UL Standards:
 - 1. UL 1598 – Luminaires (Tri-national standard)
 - 2. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products
 - 3. UL 8753/ULC-S8753 – Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines
 - 4. UL 8754/ULC-S8754 – Holders, Bases, and Connectors for Solid-State (LED) Light Engines and Arrays.
 - 5. UL 935, UL 1029, UL 542 – Ballasts
 - 6. UL 496 – Lampholders
 - 7. UL 924 – Emergency Lighting and Power Equipment
- L. NFPA Compliance: Comply with applicable requirements of NFPA 78, Lightning Protection Code, pertaining to installation of exterior lighting fixtures.
- M. Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work not conforming to these codes. Where work is shown to exceed minimum code requirements, comply with the Drawings and Specifications.
- N. Codes and Standards: Provide luminaires, poles, standards and appurtenances conforming to the following:
 - 1. American National Standards Institute (ANSI):
 - a. C2: National Electrical Safety Code.

2. Conform to applicable sections of American Society for Testing and Materials (ASTM).
 - a. B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
3. Conform to applicable sections of Certified Ballast Manufacturer's Association (CBM) Standards for Fluorescent Lamp Ballasts.
4. National Electrical Manufacturers Association (NEMA):
 - a. FA1: Outdoor Floodlighting Equipment.
 - b. SH5: Tubular Steel, Aluminum, and Prestressed Concrete Poles.
5. Conform to applicable sections of National Fire Protection Association (NFPA) 70, National Electrical Code.
6. Underwriters Laboratories, Inc. (UL):
 - a. 57: Electric Lighting Fixtures
7. Conform to all local requirements for maximum pole heights and pole setback distances from property lines.

1.6. DELIVERY, STORAGE, AND HANDLING OF POLES

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory applied pole wrappings on poles until just before pole installation. Handle poles with web fabric straps.
- D. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.
- E. Store exterior lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.
- F. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.
- G. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during the remainder of the construction period.

1.7. WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty: Written warranty, signed by Manufacturer and Installer agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies Owner may have under requirements of the Contract Documents.
1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
 2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
 3. Warranty Period: Manufacturer's standard, but not less than three years from date of Substantial Completion for poles, and not less than one year from date of Substantial Completion for luminaires.

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. LED Circuit Boards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 2. Glass and Plastic Lenses and Covers: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 3. Electronic LED Drivers: 1 for every 20 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.

1.9. COORDINATION

- A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2. PRODUCTS

2.1. MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not necessarily limited to, the products indicated on the "Exterior Lighting Fixture Schedule" on the Contract Drawings.
1. The suitability of named (basis of design) fixture only has been verified. Alternate fixtures may be submitted for review, but shall be equal to or better in quality and performance to that of named item, and must be suitable for application.
 2. By providing other than named fixture, Contractor assumes full responsibility for all necessary adjustments.
 3. Data listed and model number shown for each fixture type indicate minimum

requirements and no exceptions will be made.

2.2. GENERAL PRODUCT REQUIREMENTS

- A. Comply with IESNA RP 8 for parameters of lateral light distribution patterns indicated for luminaires.
- B. Metal Parts: Free from burrs, sharp corners, and edges.
- C. Sheet Metal Components: Corrosion resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Housings: Rigidly formed, weather, and light tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.
- F. Hardware: All hardware (e.g. screws, nuts, washers, latches, etc.) for fixtures in damp/wet locations shall be stainless steel, unless otherwise indicated on the Drawings.
- G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
- H. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- I. Lenses and Refractors: Materials as indicated. Use heat and aging resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

2.3. LUMINAIRES

- A. Refer to "Exterior Lighting Fixture Schedule" on the Contract Drawings.

2.4. LUMINAIRE SUPPORT COMPONENTS

- A. Description: Comply with AASHTO LTS 3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.
- B. Wind Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation. Strength Analysis: For each pole type and luminaire

combination, 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.

- C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.
- D. Mountings, Fasteners, and Appurtenances: Corrosion resistant items compatible with support components.
 - 1. Materials: Will not cause galvanic action at contact points.
 - 2. Mountings: Correctly position luminaire to provide indicated light distribution.
 - 3. Anchor Bolts, Nuts, and Washers: Hot dip galvanized after fabrication unless stainless steel items are indicated.
 - 4. Anchor Bolt Template: Plywood or steel.
- E. Provide poles with mast arms, brackets, and bases as indicated on the Drawings. Poles shall meet all requirements set forth in this Specification. Substitutions shall match exactly the characteristics of the pole specified in this Specification.
- F. Mast arms and pole-top mounting brackets for luminaires shall be manufactured specifically for the pole and luminaire submitted.
- G. Coordinate with pole and luminaire manufacturers for assembly details, wind loading and vibration analysis, and compatibility of materials for electrolysis free attachment and connection.
- H. Structural and Mechanical Design: Use a safety factor of 5.0 for static and dynamic loading of load bearing components, including cable.
- I. Concrete Pole Foundations: Size per Drawings. Design Strength: 3000 psig 20.7 MPa, 28 day compressive strength. Rub concrete to a smooth finish.
- J. Handholes: Provide manufacturer's reinforced type removable weatherproof gasketed coverplate. Provide welded 2-inch (12 mm) threaded grounding lug centered approximately 12 inches above the base. Handholes shall have a minimum clear access opening of 2-1/2-inches x 5-inches, unless otherwise noted.
- K. Base Cover: Each pole shall be provided with a base cover fabricated from the above-specified alloy. The cover shall be attached to the pole by means of tamperproof hardware.
- L. Anchor Bolts: All anchor bolts shall be fabricated of hot rolled special quality carbon steel with minimum 50,000 psi yield strength, or as recommended by Manufacturer. Bolts shall be furnished with nuts and washers. All bolts and hardware shall be zinc electro-plated after fabrication.

2.5. LED ELECTRONIC DRIVERS

- A. Manufacturers: Provide quality LED electronic drivers by the manufacturers listed below. Off-brand/generic electronic drivers shall not be acceptable.

1. Advance (Philips Lighting Electronics)
2. eldo LED
3. General Electric (GE) Lighting
4. Lutron
5. Osram Sylvania
6. Samsung
7. Universal Lighting Technologies, Inc.

B. General Requirements:

1. Suitable for operating type and quantity of LED sources indicated at full light output.
2. No PCBs.
3. Suitable for dry and damp locations.
4. Starting temperature: 0 degrees Celsius.
5. 50,000 hour (minimum) design life.
6. Class 2 output UL recognized to UL and CSA requirements.

C. Electrical Requirements:

1. 0-10V dimming standard.
2. Power Factor: 90 percent (0.9) minimum.
3. Total Harmonic Distortion (THD): Less than 20 percent.
4. Sound Rating: A.
5. Short circuit and overload protection standard.
6. Inherent thermal protection standard.

D. Listings:

1. ANSI C62.41: Category A for transient protection.
2. ANSI C82.11
3. FCC Part 15: Non-consumer equipment EMC.
4. UL 1310: Standard for Class 2 Power Units.

- E. Warranty:
 - 1. Minimum five-year warranty.

2.6. LED LIGHT SOURCES

- A. Manufacturers: Provide quality LED light sources by the manufacturers listed below. Off brand/generic light sources shall not be acceptable.
 - 1. Cree
 - 2. Osram
 - 3. Philips
 - 4. Samsung
- B. Correlated color temperature (CCT): As indicated on the Contract Drawings.
- C. Light sources shall have a maximum deviation of 3-step Macadam Ellipses.
- D. Color rendering index (CRI): 80 CRI minimum.
- E. L70 rating shall meet or exceed value indicated on the exterior lighting fixture schedule.
- F. Light sources shall be rated for low temperature applications (0°F, minimum).

2.7. FINISHES

- A. Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.
- B. Provide finishes on poles, mounting arms/brackets, and luminaires as indicated in the Lighting Fixture Schedule.

2.8. SPLICES, TAPS

- A. All splices underground in hand holes or other wet locations shall be waterproof and made with Scotchcast 85 Multi-Mold Splicing Kits, or approved equal.
- B. All taps in pole bases shall utilize insulated connectors as specified in Division 26 Section, "Conductors and Cables".
- C. Tap wiring to luminaire shall incorporate Bus type HEB waterproof in line fuseholder with 12 AWG XHHW conductors as recommended by ballast manufacturer.
- D. Splices in hand holes shall be supported on bricks 8-inches above bottom of handhole. Splices shall be kept to a minimum and are prohibited in locations other than hand holes, pull boxes or lighting unit bases, except for retaining circuitry of existing underground wiring where existing poles or wiring are distributed.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine areas and conditions under which roadway, parking and outdoor lighting fixtures are to be installed and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2. FIELD COORDINATION

- A. The Contractor shall be responsible for all field coordination, including verification of property lines, right of ways and other utilities.
- B. Contractor shall locate poles and underground conduits within property lines. Contractor shall locate poles in compliance with local setback requirements.

3.3. DEMOLITION

- A. Remove all existing lighting poles, fixtures, bases, and wiring which are indicated to be removed on the Drawings, and/or are obstacles to construction.

3.4. INSTALLATION

- A. Concrete Foundations: Construct concrete foundations with 3000 pound, 28-day concrete.
 - 1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor bolt templates by comparing with actual pole bases furnished.
 - 2. Finish for Parts Exposed to View: Trowel and rub smooth.
- B. Install poles in compliance with ANSI C2, with Manufacturer's written instructions and as follows:
 - 1. Use web fabric slings (not chain or cable) to raise and set poles.
 - 2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 3. Secure poles level, plumb, and square. Provide shimming and grouting of pole base to maintain luminaire in a true vertical position.
 - 4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.
 - 5. Use a short piece of 1/2 inch (13 mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- C. Luminaire Attachment: Fasten to indicated structural supports.
- D. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

- E. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.
- F. Install exterior lighting fixtures at locations and heights as indicated in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's Standard of Installation, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

3.5. UNDERGROUND DUCT LINES

- A. Duct lines shall be polyvinylchloride (PVC) heavy wall plastic ducts for installation without concrete encasement.
- B. Conductor AWG size shall be as indicated on the drawings, minimum 10 AWG. Conductors shall be type THW. Provide for each lighting branch circuit shown on the Contract Drawings, a separate green grounding conductor sized in accordance with NEC.
- C. Duct lines shall be installed in a trench minimum 24 inches below grade. Trench shall be cleaned of all rock, gravel or debris larger than 1/4 inch diameter. Duct lines shall rest on minimum 3-inch clean sand bed and shall have minimum 3 inches clean sand over cover. Trench earth backfill shall be free of rock, gravel or other debris. Open trenches shall be limited to 50 linear feet before backfilling.
- D. Metal conduit sleeves of sufficient size shall be installed in concrete lighting standard bases to allow the entry/exit of branch circuit wiring. Sleeves shall be capped with bushings.
- E. All elbows and all ducts installed above grade shall be rigid galvanized steel.

3.6. CONNECTIONS

- A. Ground equipment: 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. Ground metal poles/support structures and fixtures according to Division 26 Section "Grounding and Bonding".
 - 1. Bond metallic components of lighting fixtures, poles, and foundations. Connect luminaires to grounding conductors routed with associated branch circuit phase and neutral conductor(s) and to grounding electrode with 4 AWG conductor.
 - 2. Provide 10-foot (3-m) driven ground rod at each pole, exothermically welded to grounding conductor.

3.7. FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged units.
- B. Advance Notice: Give dates and times for field tests.
- C. Provide instruments to make and record test results.

- D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with power source, and as follows:
 - 1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.
 - 2. Check intensity and uniformity of illumination.
 - 3. Check electronic LED drivers and circuit boards for proper operation.
- E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.
- F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- G. Set, adjust, and aim adjustable fixtures at night. Repeat procedure until units provide illumination acceptable to the Owner.

3.8. CLEANING AND ADJUSTING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities, in night test of system. Verify that measured illuminance values comply with isolux plot diagram values and point-by-point calculations.
- C. Touch up damage to finishes.

3.9. DEMONSTRATION

- A. Provide a minimum of four (4) hours of demonstration of luminaire operation.
- B. Upon completion of installation of exterior lighting fixtures and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

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. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Grout.
 - 4. Common electronic safety and security installation requirements.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 28 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.
- H. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of

rough-in or fabrication.

1.3 CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 28 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:
 - 1. A list of not less than five comparable projects which the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership in trade or professional organizations where required.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.4 PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with Division 01 Section, General Requirements.
- C. Notify Inspection Authorities to schedule inspections of work.
- D. Notify Architect in advance of scheduled inspections.
- E. A foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections

1.5 EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.
- B. Examine and verify specific conditions described in individual Specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.6 INTERPRETATION OF DOCUMENTS

- A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.
- B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.
- C. All general trades and existing conditions shall be checked before installing any devices, cabling, etc.
- D. Equipment sizes shown on the Drawings are estimated. Before installing any cabling, conduit, or boxes obtain the exact equipment requirements and install cabling, conduit, boxes or other item of the correct size for the equipment actually installed.
- E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be in-stalled.
- F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed be-cause of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, and Owner.
- H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.
- I. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.7 MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable

for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.8 ELECTRONIC SAFETY AND SECURITY WORK UNDER OTHER DIVISIONS

A. Architectural Equipment and Systems

- 1. In general, any electrically operated or controlled equipment furnished under Architectural divisions shall be supplied with control wiring, transformers, contacts, etc.
- 2. Division 28 shall provide fire alarm connections to such equipment in accordance with applicable codes and standards.
- 3. Architectural Equipment refers to, but is not limited to the following:
 - a. Cabinets, Casework and Countertops
 - i. Do not install fire alarm devices, etc. behind casework, cabinets, etc. Coordinate with approved casework shop drawings.
 - b. Door Hardware
 - i. Includes, but is not limited to electric strikes, magnetic hold-open devices, overhead doors, smoke/fire doors, etc.
 - ii. Verify voltages of door hardware with approved door hardware shop drawings.
 - iii. Coordinate mounting height and location of magnetic hold-open devices with Architect.
 - iv. Coordinate fire alarm connections for overhead coiling doors/grilles with approved shop drawings.
 - v. Coordinate locations of smoke detectors serving fire/smoke doors with architectural drawings.
 - c. Glazing Systems

- i. Includes but is not limited to commercial storefront, curtain walls, skylights, windows, etc.
- ii. Do not install fire alarm initiation and notification appliances on glazing systems wherever possible. Where devices must be installed on glazing systems, indicate the same on fire alarm system shop drawings and obtain the permission of the Architect.

B. HVAC Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under HVAC divisions shall be supplied with control wiring, transformers, contacts, etc.
2. Division 28 shall provide fire alarm connections to such equipment in accordance with applicable codes and standards.
3. Certain mechanical units are furnished from the factory with motor starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, Division 28 shall coordinate with Division 23 such that only one set of starters, fuses, switches, etc. is provided.
4. In general, control and interlock equipment (including, but not limited to wiring, conduit, trans-formers, relays, contacts, etc.) for HVAC equipment and systems is furnished under Division 23. Division 28 shall install and connect all equipment as necessary.
5. HVAC equipment refers to, but is not limited to the following:
 - a. Energy Recovery Ventilators
 - i. Provide duct-mounted smoke detectors and remote test stations for units over 2,000cfm.
 - ii. Coordinate detector installation with Division 23.
 - iii. Coordinate duct-mounted smoke detector sampling tube lengths with duct dimensions.
 - b. Gas-Fired Equipment
 - i. Provide carbon monoxide detectors in all spaces with gas-fired equipment.
 - c. Heat Pumps
 - i. Provide duct-mounted smoke detectors and remote test stations for units over 2,000cfm.
 - ii. Coordinate detector installation with Division 23.
 - iii. Coordinate duct-mounted smoke detector sampling tube lengths with duct dimensions.

- d. Make-up Air Units
 - i. Provide duct-mounted smoke detectors and remote test stations for units over 2,000cfm.
 - ii. Coordinate detector install with Division 23.
 - iii. Coordinate duct-mounted smoke detector sampling tube lengths with duct dimensions.
- C. Plumbing Equipment and Systems
 - 1. In general, any electrically operated or controlled equipment furnished under Plumbing divisions shall be supplied with control wiring, transformers, contacts, etc.
 - 2. Division 28 shall provide fire alarm connections to such equipment in accordance with all applicable codes and standards.
 - 3. Plumbing equipment refers to, but is not limited to the following:
 - a. Fire protection/suppression system.
 - i. Provide addressable interface modules for all tamper switches, flow switches, etc.
 - ii. Provide connection to electric gong if provided.
- D. Sound Equipment and Systems
 - 1. In general, any electrically operated or controlled equipment furnished by the Owner shall be supplied with control wiring, transformers, contacts, etc.
 - 2. Division 28 shall provide fire alarm connections to such equipment in accordance with all applicable codes and standards.
 - 3. Sound equipment refers to, but is not limited to the following:
 - a. Local sound systems for building, etc.
 - i. Provide fire alarm addressable interface modules and interlock with sound systems to shunt audio signals during a fire event.
 - ii. Verify connection requirements prior to rough-in.
 - iii. Coordinate with approved shop drawings where applicable.

1.9 FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:

1. ADA - Americans with Disabilities Act
2. ANSI - American National Standards Institute
3. ASTM - American Society for Testing and Materials
4. CSA - Canadian Standards Association
5. DNREC - Delaware Department of Natural Resources and Environmental Control
6. EPA - Environmental Protection Agency
7. FM - Factory Mutual
8. IBC - International Building Code
9. IEEE - Institute of Electrical and Electronics Engineers
10. NEC - National Electrical Code
11. NECA - National Electrical Contractors Association
12. NEMA - National Electrical Manufacturers Association
13. NFPA - National Fire Protection Association
14. OSHA - Occupational Safety and Health Act
15. UL - Underwriters' Laboratories

B. Electronic safety and security construction materials shall, where a listing is normal for the particular class of material, be listed in Electrical Construction Materials List of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Equipment shall, where a listing is normal for the particular class of equipment, be listed by Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.11 SUBMITTALS

A. Product Data: Include complete descriptive product data for items specified in Part 2 of this Section.

1.12 SUBMITTAL PROCEDURES

- A. Refer to Division 01, Section "Submittal Procedures" for requirements in addition to those indicated herein.
- B. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect, and/or Engineer, to be in the best interest of the Owner.
- C. After acceptance of Material and Equipment List, submit three (3) copies, or more as required under the General Conditions, of complete descriptive data for all items as outlined be-low.
- D. Electronic submittals shall be prepared as a Portable Document Format (PDF) file and shall include as page 1 the Contractor's stamp, followed by the submittal contents. Submittal form shall identify the Project, Contractor, Subcontractor or Supplier, and pertinent Contract Document references.
- E. Submittals shall consist of specifications, product data sheets, manufacturer's catalog cuts, dimensional shop drawings, wiring diagrams, installation instructions, samples, and any other information necessary to indicate complete compliance with Contract Documents.
- F. Submittals shall include, but not be limited to, the following information: size, type, functional characteristics, compliance with standards in Division 28, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Document requirements.
- G. Identify submittals, indicating intended application, location and service of submitted items. Refer to Specification sections or paragraphs and Drawings where applicable.
- H. Clearly indicate exact type, model number, style, size, operating characteristics, ratings, options and special features of proposed item specifically for application to this project. Submittals of a general nature will not be acceptable.
- I. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- J. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and all electrical requirements for equipment submitted. The Contractor shall be responsible for correctness of all submittals.
- K. Submittals will be reviewed for general compliance with design concept in accordance with Con-tract Documents, but dimensions, quantities, or other details will not be verified.
- L. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.
- M. For substituted items, clearly list on the first page of the submittal all differences between

the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the Specification requirements if differences have not been clearly indicated in the submittal.

- N. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- O. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct submittal. Identify all submittals by the name of the item/system and the applicable Specification Section and/or Drawing number. Grouping of items/systems that are not related shall be unacceptable.
 - 1. Items and Systems
 - a. Access Doors
 - b. Conduit and Raceways
 - c. Fire Alarm System Components
 - i. Alphanumeric Annunciator Panel(s)
 - ii. Fire Alarm Control Panel
 - iii. Graphic Annunciator Panel
 - iv. Line Extenders
 - v. NAC Panels
 - vi. Initiation Devices (Pull Stations, Smoke Detectors, Heat Detectors, etc.)
 - vii. Notification Appliances (Horns, Strobes, Speaker Strobes, etc.)
 - viii. Wire and Cable
 - d. Firestopping Materials
 - e. Grounding Products
 - f. Hangers and Supports
 - g. Identification Products
 - h. Operation and Maintenance Manuals
 - i. Plywood Backboards
 - j. Record Drawings

- k. Sleeves
 - l. Sleeve Seals
 - m. Software
 - n. System Labeling Schedules
 - o. Testing Agency Qualifications
 - p. Tests and Reports
 - q. Transformers, Control
 - r. UPS Systems & Batteries
 - s. Wiring Diagrams
- P. Submit for approval any other submittals as required by the Architect, Engineer, or Owner. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- Q. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.13 SHOP DRAWINGS

- A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.
- B. Shop drawings shall include identification of products being installed, compliance with specified standards, notation of coordination requirements, notation of dimensions verified by field measurement, etc. Do not base shop drawings on reproductions of the Contract Documents or standard printed data.
- C. Submit shop drawings concurrent with product data. Shop drawings received without associated product data will be returned without review.
- D. Submit for approval schematic diagrams of each electrical system installed in the building, including but not limited to Riser Diagrams and Schematic Wiring Diagrams for the following systems:
 - 1. Fire Alarm System
- E. Shop Drawing diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be inserted into the O&M Manual specified herein.
- F. Submit for approval any other shop drawings as required by the Architect, Engineer, or

Owner. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

- G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.
- H. Refer to individual Specification Sections and Contract Drawings for additional shop drawing requirements.
- I. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.14 DEFINITIONS

- A. Approve: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. Building Line: Exterior wall of building.
- C. Concealed: Hidden from sight in chases, formed spaces, shafts, hung ceilings, or embedded in construction.
- D. Conduits include conduit, all fittings, identification, and other accessories relative to such conduit.
- E. Contractor: The Electrical Contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- F. EPDM: Ethylene-propylene-diene terpolymer rubber
- G. Exposed: Not installed underground or concealed as defined above.
- H. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. Furnish and install or provide: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- J. Location, Damp: Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc...
- K. Location, Dry: A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.
- L. Location, Wet: Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including

those under canopies, roofed open porches, etc...) commercial kitchens, and vehicle washing areas.

- M. NBR: Acrylonitrile-butadiene rubber.
- N. Review: Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.15 RECORD DRAWINGS

- A. Upon completion of the electrical installations, the Contractor shall deliver to the Architect one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering the same to the Architect.

1.16 WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the General Conditions.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The Contractor guarantees for a two (2) year period from the time of final acceptance by the Owner:
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
 - 3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, with-out cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
 - 4. That the entire work shall be water-tight and leak-proof.

1.17 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared three (3) hardcopies and one (1) electronic copy of the Operation and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.

- B. The manual shall be bound in a three ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: Operation and Maintenance Manual – DTCC Owens Campus Automotive Center – Electronic Safety and Security. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.
- C. Provide the following data in the manual:
1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 3. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's Comments (if any).
 4. Manufacturer's extended limited warranties on equipment.
 5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
 6. Provide supplier and subcontractor's names, address, and phone number.
 7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
 8. Access panel charts with index illustrating the location and purpose of access panels.
 9. Approved Fire Marshal inspection report and fire alarm system record of completion per NFPA 72.
 10. Start-up and test reports for equipment.
- D. Submit Operation and Maintenance Manual prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operation and Maintenance Manuals be reviewed and approved.

PART 2 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, 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.

2.2 GROUT

- A. Nonmetallic, Non-Shrink Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3 PROTECTIVE WIRE GUARDS/ VANDAL SHIELDS

- A. Provide protective guards over devices subject to physical damage. All devices installed in garage, in mechanical and electrical rooms, and other areas subject to damage shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800-328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).
- B. Devices to be provided with protective guards include, but are not limited to, the following:
 - 1. Fire Alarm Pull Stations
 - 2. Smoke/Heat Detectors
 - 3. Fire Alarm Audio/Visual Devices (Horns, Strobes, etc....)
 - 4. Security Devices/Motion Detectors
- C. Wireguards shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Wireguard shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall match the device finish, e.g. red.
- D. Indoor Protective Shield: Factory-fabricated, clear thermoplastic 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.
- E. Protective Guards/ Vandal Shields shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

PART 3 EXECUTION

3.1 TEMPORARY FACILITIES

- A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.
- B. Description: Furnish and install the necessary equipment for temporary fire alarm connections and all temporary wiring as required.
- C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.
- D. Remove all temporary installations and connections after permanent power is established and/or prior to completion of the project.

3.2 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. 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.
- D. Install equipment with working space and dedicated space in strict accordance with NEC Article 110.
- E. 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.
- F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- G. Verify exact requirements for each piece of equipment receiving one or more fire alarm connections.
- H. Include any and all items required by the National Electrical Code, NFPA 72, and/or field conditions for the proper connection and installation of each piece of equipment.
- I. Make all connections to equipment in accordance with manufacturer's instructions.
- J. Right of Way: Give to piping systems installed at a required slope.
- K. Coordinate electronic safety and security work under other Divisions in accordance with Part 1 of this Section, Article "Electronic Safety and Security Work Under Other Divisions".

3.3 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. 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. 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.
- D. Cut sleeves to length for mounting flush with both surfaces of walls.
- E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

- F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. 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.
- H. 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.
- I. 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 of Division 26 Section "Electrical Firestopping".
- J. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and joint sealant/grout.

3.4 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 26 Section, "Electrical Firestopping".

3.5 SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.
- C. Refer to Division 26 Section "Hangers and Supports" for additional requirements.

3.6 PROVISIONS FOR ACCESS

- A. The Contractor shall provide access panels and doors for all concealed equipment, and other de-vices requiring maintenance, service, adjustment or manual operation.
- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to

fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
 2. Hard Finish Plaster: Style K or L
 3. Masonry or Dry Wall: Style M
- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of Specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.
- F. Provide sufficient access and working space for repair and maintenance about all lighting and electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.7 PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 28 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.
- F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the Architect.

- H. All exposed conduit, boxes, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.8 COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.

3.9 PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.10 OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
- C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.
- D. Do not use electronic safety and security systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section "Temporary Facilities and Controls".
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.11 TESTING AND ADJUSTMENT

- A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.
- B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

- C. Provide circuits that are free from ground faults, short circuits and open circuits.
- D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.
- E. Submit all test results to the Architect for approval.

3.12 WALL AND FLOOR PENETRATIONS

- A. All penetrations of partitions, ceilings, roofs and floors under Division 28 shall be sleeved, sealed, and caulked as specified herein.
- B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, "Electrical Firestopping".
- C. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations.
- D. Conduit sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.

3.13 EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.14 CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 28. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.
- B. Do not cut structural members without approval from the Architect or Structural Engineer.

3.15 PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are

necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

3.16 CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for items required under Division 28. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.
- B. Concrete shall achieve compressive strength not less than 3,000 psi after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.
- D. Properly align, level, and grout all equipment where necessary.

3.17 COORDINATION

- A. 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.
 - 5. To provide working space and dedicated space clearances per NEC Article 110.26.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. 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 Part 2 of this Section.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Electrical Firestopping".

END OF SECTION

OUTAGE REQUEST FORM

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE - TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ___ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ___ NO: ___ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-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. Section includes a non-proprietary digital, addressable fire alarm system, including, but not limited to the following:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Notification appliances.
 - 5. Device guards.
 - 6. Magnetic door holders.
 - 7. Graphic annunciator.
 - 8. Remote annunciator.
 - 9. Addressable interface device.
 - 10. Digital alarm communicator transmitter.
 - 11. Network communications.
- B. Related Requirements:
 - 1. Division 28 Section "Common Work Results for Electronic Safety and Security" for general installation requirements for fire-alarm systems.

1.3. DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.4. ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 - 9. Include performance parameters and installation details for each detector.
 - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 11. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Architect.
 - 2. 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. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 - 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5. INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.6. CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components 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 and deliver copies to authorities having jurisdiction]:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 - g. Record copy of site-specific software.
 - h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - i. Equipment tested.
 - ii. Frequency of testing of installed components.
 - iii. Frequency of inspection of installed components.
 - iv. Requirements and recommendations related to results of

- maintenance.
 - v. Manufacturer's user training manuals.
 - i. Manufacturer's required maintenance related to system warranty requirements.
 - j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. 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.

1.7. MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 3. Smoke Detectors, Carbon Monoxide Detector: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8. QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Final programming, testing, and commissioning shall be by personnel certified by NICET as fire-alarm Level IV (minimum) technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9. PROJECT CONDITIONS

- A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10. WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2. PRODUCTS

2.1. SYSTEM DESCRIPTION

- A. The Fire Alarm / Life Safety System supplied under this specification shall be a microprocessor based network system. All Control Panel Assemblies and connected Field Appliances shall be both designed and manufactured by the same company, and shall be tested and cross listed as compatible to ensure that a fully functioning Life Safety System is designed and installed.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. All components provided shall be listed for use with the selected system.
- 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.

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. Smoke detectors.
 - 3. Duct smoke detectors.
 - 4. Carbon monoxide detectors.
 - 5. Automatic sprinkler system water flow.
 - 6. Fire-extinguishing system operation.

7. Dry system pressure flow switch.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
 2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels.
 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. Activate emergency shutoffs for gas and fuel supplies.
 8. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
 3. Independent fire-detection and -suppression systems.
 4. User disabling of zones or individual devices.
 5. Loss of communication with any panel on the network.
 6. System trouble signal initiation shall be by one or more of the following devices and actions:
 7. Open circuits, shorts, and grounds in designated circuits.
 8. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 9. Loss of communication with any addressable sensor, input module, relay, control module or Ethernet module.
 10. Loss of primary power at fire-alarm control unit.
 11. Ground or a single break in internal circuits of fire-alarm control unit.
 12. Abnormal ac voltage at fire-alarm control unit.
 13. Break in standby battery circuitry.

14. Failure of battery charging.
 15. Abnormal position of any switch at fire-alarm control unit or annunciator.
- D. System Supervisory Signal Actions:
1. Initiate notification appliances.
 2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels.
 3. Record the event in system memory.
 4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 5. Transmit system status to building management system.
 6. Display system status on remote annunciator(s).
- 2.3. MANUFACTURERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Edwards System Technology (EST)
 2. Notifier.
 3. SimplexGrinnell LP.
- 2.4. FIRE ALARM CONTROL UNIT
- A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, 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.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- 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, two line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

Characteristics and Features						
Pathway Class Designation	Include Redundant Path	Operates with One(1) Open Circuit	Operates with One(1) Short Circuit	Path Integrity Monitoring	End-to-End Communication	Remarks
A	Yes	Yes	No	Yes	Yes	Better
B	No	No	No	Yes	Yes	Good
X	Yes	Yes	Yes	Yes	Yes	Best

1. Pathway Class Designations: NFPA 72, Class B.

Characteristics and Features						
Pathway Survivability Level	Is survivability required?	Is the building fully sprinklered?	Is cabling installed in conduit?	Is cabling 2-hour fire rated?	Is voice evacuation required?	Remarks
0	No	No	No	No	No	
1	Yes	Yes	Yes	No	No	
2	Yes	No	No	Yes	Yes	
3	Yes	Yes	No	Yes	Yes	

2. Pathway Survivability: Level 2.
3. Install no more than 50 addressable devices on each signaling-line circuit.
4. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).

- c. One USB port for PC configuration.
 - d.
 - e. One RS 232 port for voice evacuation interface.
- D. Smoke-Alarm Verification:
- 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3. Sound general alarm if the alarm is verified.
 - 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Notification-Appliance Circuit:
- 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 - 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 - 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. 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.
- G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- H. 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 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.
- I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
- 1. Batteries: Sealed lead calcium.
 - 2. Batteries shall be sized to provide 10 minutes of alarm power and 24 hours of standby power.

- J. 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.

2.5. MANUAL PULL STATIONS

- A. General Requirements for Manual Pull Stations: Comply with UL 38. Pull stations 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. Public/Finished Areas (e.g. corridors, classrooms, shop etc.): Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Provide vandal shield for each station as specified under "Device Guards" in this Section.
 - 2. Station Reset: Key- or wrench-operated switch.

2.6. SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 3. 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. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units 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 (57 or 68 deg C).
 - c. Multiple levels of detection sensitivity for each sensor.

d. Sensitivity levels based on time of day.

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.).
3. 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.
4. 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.).
5. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
6. Each sensor shall have multiple levels of detection sensitivity.
7. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
8. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
9. ATC System Interface: Fully programmable relay/contact for duct detector status to be monitored by the building ATC system.

2.7. MULTI-SENSOR DETECTORS

- A. 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. 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. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall 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, red unless otherwise required by the authorities having jurisdiction.

2.9. GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch- (4.76-mm-) thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by LED lamps as indicated on the Contract Drawings. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Semiflush mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/32-inch per foot scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

2.10. ADDRESSABLE INTERFACE DEVICES

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Control Module:

1. Operate notification devices.

2.11. DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two (2) 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 either 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. Transmitter shall include internet protocol (IP) module for connection to data network.
- D. 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.
- E. 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.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Earth fault.
 - 8. 24 hour test signal.
 - 9. Abnormal test signal.
 - 10. Communication bus failure.
 - 11. Secondary Power: Integral rechargeable battery and automatic charger.

- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12. INTERNET PROTOCOL DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Internet Protocol (IP) digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from the fire alarm control unit and the fire-alarm control unit shall go off-hook to dial the central station. The dialer capture module shall detect the off-hook condition and provide the fire-alarm control unit with a dial tone. When the fire-alarm control unit detects the dial tone, it shall begin dialing the remote central station. The dialer capture module shall consider the three second period after dialing as confirmation that the number dialing has been completed. The fire-alarm control unit shall then report(s) to the dialer capture module, which in turn shall acknowledge it has successfully received the report(s) from the fire-alarm control unit. The dialer capture module shall then send the report(s) to the GSM communications module, which shall transmit the report(s) to the remote central station either over the internet or the GSM network. Once all reports have been sent, the fire-alarm control unit shall return on-hook. A power monitoring module shall monitor the power supply circuit and shall transmit a supervisory and/or trouble alarm to the fire-alarm control unit in the event that a loss of power is detected.
- C. Local functions and display at the IP digital alarm communicator transmitter shall include the following:
 - 1. Verification of vital system status.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station of 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.
 - 5. Loss of power.
 - 6. Low battery.

7. Earth fault.
 8. 24 hour test signal.
 9. Abnormal test signal.
 10. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to the remote central station.

2.13. CIRCUIT PROTECTION DEVICES

- A. General Requirements for Circuit Protection Devices: Comply with UL 497B, "Protectors for Data Communications and Fire Alarm Circuits" and NFPA 70, "National Electrical Code". Circuit protection devices shall minimize the energy from electrical transients caused by lightning or disturbances on high voltage power lines that can cause damage on low voltage fire alarm circuits.
- B. Provide circuit protection for all fire alarm system wiring that is run external to the building, including but not limited to, the following:
1. DC Power (200 mA maximum)
 2. Data communications
 3. Monitor circuits
 4. Audio riser circuits
 5. Firefighter telephone circuits
 6. DC notification appliance circuits (NACs)
 7. Speaker circuit NACs (25 VRMS)
- C. Operating Specifications:
1. Line-to-Line Voltage Rating:
 - a. Continuous: 38 VDC, 28 VAC RMS
 - b. Clamping: 47 V
 2. Line-to-Earth Voltage Rating:
 - a. Continuous: 45 VDC, 35 VAC RMS
 - b. Clamping: 56 V
 3. Shield-to-Earth Voltage Rating:

- a. Continuous: 48 VDC, 33 VAC RMS
- b. Clamping: 75 V
- 4. Line-to-Line Capacitance: 0.006 micro-farads (μ F)
- 5. Continuous Current Rating: 200 mA maximum
- 6. Series Resistance: 3 ohms (Ω) / line
- 7. Response Time:
 - a. Line-to-Line: <1 nanosecond
 - b. Line-to-Earth: <25 nanoseconds
- 8. Maximum Current:
 - a. Line-to-Line: 2000A (10 x 50 μ sec pulse)
 - b. Line-to-Earth: 2000A (8 x 20 μ sec pulse)
 - c. Shield-to-Earth: 5000A (10 x 50 μ sec)
- D. Mechanical Specifications:
 - 1. Dimensions: 2-7/16"W x 1-3/8"D x 1-1/16"H (62mm x 35mm x 27mm)
 - 2. Package: Beige, epoxy encapsulated
 - 3. Electrical Box Requirement: 4" (102 mm) square box, 2-1/8" minimum depth
 - 4. Temperature Rating: 32°F to 120°F (0°C to 49°C)
 - 5. Humidity Rating: 10-95% relative humidity (RH) at 30 degrees C
 - 6. Signal Leads: Color coded, 18 AWG, 10" long (254 mm)
 - 7. Ground Lead: Green, 14 AWG, 10" long (254 mm)

2.14. NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

2.15. DEVICE GUARDS

- A. Wire Guards: Welded wire mesh of size and shape for each notification appliance, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Paint of color to match the protected device.

- B. Vandal Shields: Clear hinged enclosures for manual pull stations
 - 1. Indoor Protective Shield: Factory-fabricated, clear thermoplastic 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.
 - 2. Weatherproof Protective Shield: Factory-fabricated, clear thermoplastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

4. Provide protective shields as specified in Part 2 of this Section for all manual fire-alarm box locations.
- D. Smoke- or Heat-Detector Spacing:
1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 2. Provide a remote test station for each duct smoke detector.
- G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, 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 (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
- J. Provide manufacturer's surface mount adapter skirts to conceal surface mounted outlet boxes and/or extension rings where required for deep devices.

K. Circuit Protection Devices:

1. Fire alarm system wiring that is run external to the building and is protected by circuit protection devices shall be installed in accordance with the individual system component's installation instructions including properly grounded, twisted and shielded pairs, and observance of the following precautions:
 - a. Circuit protection devices shall be located as close as possible to the point at which the circuits leave or enter the building(s) and shall be installed in dedicated electrical outlet boxes. Outlet boxes shall be painted red and permanently labeled "Fire Alarm".
 - b. The total maximum wire length shall be determined by the individual application's allowable limit as specified with circuit protection devices, but must not exceed 3270 ft (1 km).
 - c. The grounding conductor shall be 12 AWG with a maximum length of 28 ft (8.5 m), run in as straight a line as possible and connected to the building grounding electrode system per NFPA 70, the "National Electrical Code".

3.3. PATHWAYS

- A. Pathways concealed above accessible ceilings may be routed exposed.
- B. Exposed pathways and pathways in non-accessible locations shall be installed in conduit. Refer to Division 26 Section "Raceways and Boxes" for additional information.
- C. Exposed conduit shall be red in unfinished spaces (e.g. electrical rooms) and shall be painted to match adjacent surfaces in finished spaces. Refer to Division 26 Section, "Electrical Identification" for additional information.

3.4. 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 listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) 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 HVAC duct systems.
 2. Magnetically held-open doors.
 3. Electronically locked doors and access gates.
 4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

5. Supervisory connections at valve supervisory switches.

3.5. IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."
- B. Each piece of fire alarm equipment with a 120 VAC source circuit shall be labeled to identify the equipment designation, source circuit designation (e.g. EP1A1-1), source circuit voltage (e.g. 120V, 1PH) and source circuit origination (e.g. main electrical room D101).
- C. Each Fire Alarm System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following text printed in white lettering on a red label:
 1. "FIRE ALARM" for fire alarm systems.
- D. Install framed instructions in a location visible from fire-alarm control unit.
- E. Label each duct detector remote test station to identify equipment monitored, e.g. "AHU-1" and duct type, e.g. "supply" or "return".

3.6. 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.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7. FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction and Owner's representatives.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 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 the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "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 the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. 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.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 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" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- 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.

3.8. MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 24 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9. SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10. DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- B. Provide up to one (1) days of four (4) hours of instruction each for ten (10) persons, to be conducted at the project site with manufacturer's representative.

END OF SECTION

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Protecting existing trees, shrubs, plants and grass to remain.
- 2. Removing existing trees and other vegetation.
- 3. Clearing and grubbing.
- 4. Stripping and stockpiling topsoil.
- 5. Removing above- and below-grade site improvements.
- 6. Disconnecting, capping or sealing, and abandoning site utilities in place and removing site utilities.
- 7. Temporary erosion and sedimentation control measures.

- B. Related Sections include the following:

- 1. Division 01 Section "Temporary Construction Utilities, Facilities & Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
- 2. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
- 3. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing. The contractor is responsible for all costs associated with a utility locator service.
- C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.
- D. Contact DNREC, Division of Sediment and Stormwater to arrange a preconstruction meeting prior to any site clearing or site disturbance activities.

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 approved Sediment and Erosion Control Drawings.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones, identified in the contract documents,, before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
 - 1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Construction Manager will arrange to shut off indicated on-site utilities when requested by Contractor.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Construction Manger and Owner not less than five days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Manager's written permission.
- C. Excavate for and remove underground utilities indicated to be removed. Refer to sections covering site utilities.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 - 4. Use only hand methods for grubbing within tree protection zone.
 - 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations, in compliance with erosion and sediment control permit requirements, without intermixing with subsoil . Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Do not stockpile topsoil within tree protection zones.
 - 2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.

1.2 SECTION INCLUDES

- A. Earthwork includes areas below building foundations, below concrete slabs on grade, below paved areas and grading of all unpaved area in the site.
 - 1. Layout and staking for earthwork.
 - 2. Excavation and rough grading.
 - 3. Erosion and sediment control.
 - 4. Foundation excavation for footings.
 - 5. Establishing subgrades, leveling and proofrolling.
 - 6. Filling, backfilling and compaction.
 - 7. Keeping streets clean of materials tracked off site.
 - 8. Includes trenching, excavation and backfill for utilities.
 - 9. Maintenance and/or repair of damage to the rough grading.
 - 10. Removal and disposal of stones, debris, excess and unsuitable materials.
 - 11. Soil treatment for termite control.
 - 12. Field quality control, testing, and inspection.

1.3 DEFINITIONS

- A. Rock Excavation: Natural geological formations or other material which cannot be removed by adequate equipment (in good condition) as defined below, shall be considered a change in the scope of work and paid for by the Owner if encountered.
 - 1. Open Excavation and Grading: Rock in excess of the capabilities of a Caterpillar D-8 tractor (or equivalent) with 2 cu. yd. bucket and hydraulically operated single tooth power ripper.
 - 2. Trenches, Pits and Footings: Rock in excess of the capabilities of a Caterpillar 235 Hydraulic Backhoe (or equivalent) using a 2 ft. Bucket width (3/4 cu. yd.)
 - 3. Minimum Effort: If rock is not removed during the process of normal digging and ripping, then extend the excavation to expose the rock surface within the limit of original excavation. Contact the A/E and he may direct the sides of rock to be exposed to a depth of 3 feet. This will be to determine to the extent of additional work.
- B. Earth Excavation: Anything not classified as bedrock including as example: soils, gravels, stones, boulders, vegetation, debris, and unsuitable materials.
- C. Unsuitable Materials: All excavated materials; debris, man made or fabricated materials, concrete spoil, organic, soft, expansive, or unstable matter; all shall be disposed of as herein specified. Excessive moisture content shall not classify a material as unsuitable.

- D. Removal and disposal of unsuitable material above the subgrade elevation and placement of approved specific fill material (from on or off the site) above the subgrade elevation as directed by the Soils Engineer shall be considered a part of the work.
- E. Removal and disposal of unsuitable material approved below the subgrade elevation and placement of approved specific fill material (from on or off the site) below the subgrade elevation as directed by the Soils Engineer shall be considered a change in the scope of work.
- F. Soils Engineer or Inspection Agency: An Agency and its designated representatives who monitor and approve all earthwork operations described herein.
- G. Subgrade: The finished elevation of the earth immediately below all slabs, granular and porous fill, paving, footings, walls, etc., except the subgrade elevation shall not be higher than 12" below the existing earth elevation at the start of the project.
- H. Subgrade for utility construction: Underside of barrel of pipe, or underside of any cradle or bedding if noted on drawings, or referenced in applicable local government specifications. For pipe drains and miscellaneous structures encased in concrete or on concrete, stone and/or gravel cradle, subgrade is lowest outside surface of encasement or cradle.
- I. 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.
- J. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- K. Drainage Course: Course supporting the slab on grade that also minimizes upward capillary flow of pore water.
- L. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- M. Utilities: On site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- N. Filter Material: Course placed around drainage pipes.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Society for Testing and Materials (ASTM).
3. Delaware Department of Transportation, State Highway Administration "Standard Specifications for Materials and Construction", as amended to date (DeIDOT as hereinafter referred). Delete references to Measurement and Payment.

- B. Geotechnical Testing Agency Qualifications: Construction Manager or Owner will engage an independent testing agency (with a Geotechnical engineer licensed in the state where the project is being constructed on staff) qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

- C. Tolerances: As indicated herein.
- D. Testing: Requirements as specified herein.

1.5 SUBMITTALS

- A. Notification:
 - 1. Notify and provide data to regulatory authorities and A/E prior to commencement of work.
 - 2. Provide notice of: encounter with unknown utilities; subgrades before filling; areas requiring testing or inspection.
- B. Product Data: For the following:
 - 1. Geotextile.
 - 2. Detection Warning Tape.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D2487 of each on site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D1557 for each on site and borrow soil material proposed for fill and backfill.
 - 3. Field reports; in-place soil density tests.
 - 4. One optimum moisture – maximum density curve for each type of soil encountered.
 - 5. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - 6. Test reports must be submitted daily to the Architect and Owner.

1.6 PROJECT CONDITIONS

- A. Subsurface Conditions: Subsurface soils investigations have been made at the site. The report and logs of the test borings and test pits shall be provided. Such investigations have been made for the purposes of design only and neither the Engineers, the Owner, nor the Geotechnical Engineer guarantee adequacy or accuracy of the data, or that data are representative of all conditions to be encountered. Such information is made available for general information only and shall not relieve the Contractor of the responsibility for making his own investigations, tests, and analysis. Any additional test borings and other exploratory operations may be made by Contractor shall be at no cost to Owner.
- B. Erosion and sediment control, in addition to erosion control specified in Section 31100 and Division 1:
 - 1. Standards: Comply with the requirements of the "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas" by the U.S.D.A. Soil Conservation Service.
 - 2. Standards: Comply with the requirements of the "Delaware Sediment and Stormwater Regulations, latest edition.

3. General Erosion: Prevent erosion of earthwork; repair and correct any ditches, gullies or erosion immediately and upon occurrence.
4. Excavations: Prevent water from flowing into open excavations and toward building walls.
5. Slopes: Cover (with continuous plastic membrane) and stake all slopes steeper than 1.5 horizontal to 1 vertical.

C. Environmental Conditions:

1. Do not apply soil treatment when temperature is at or below freezing or when ground is frozen or frost is expected.
2. Do not apply soil treatment when surface water is present.

D. Existing Conditions: Accept the site in the condition which it exists at the time of the award of the contract and perform all work to the grades indicated.

1. Protect plant material, lawns and other features not designated for removal.
2. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.

E. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
2. Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by A/E and then only after acceptable temporary utility services have been provided. Provide a minimum of 48 hour notices to utility Owners and receive written notice to proceed before interrupting any utility.

F. Rock Excavation: Rock excavation may be performed with hoe rams, jack hammers, or any method the Contractor wishes to employ except for explosives.

1.7 PROTECTION

- A. Safety: Provide protective measures necessary for the safety of workmen, to the public and adjacent property. Prevent cave-ins, collapse of walls, structures and slopes, both on and adjacent to the site.
- B. Standards: Comply with regulations of local authorities having jurisdiction, including all applicable O.S.H.A. requirements.
- C. Repair: Includes the removal and replacement with new materials all materials so affected by settlement.

PART 2 - PRODUCTS

2.1 FILL AND BACKFILL

A. Satisfactory Soils:

1. Compacted fill and backfill shall be free of deleterious matter such as frozen materials, organics, wood, debris, or rock larger than 4 inches in diameter and be classified SP, SW, SM, SC, GP, GC, GM, or GW per ASTM D-2487. All material shall have a liquid limit and plasticity index not exceeding 40 and 20 respectively when tested in accordance with ASTM D-4318.
2. The minimum dry unit weight shall not be less than 105 PCF maximum dry density as determined by ASTM D-1557, modified proctor.
3. All fill and backfill materials shall be obtained from on site or from off site sources and shall be approved by the Geotechnical Engineer prior to placement.
4. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with a least 90 percent passing a 1 ½ inch sieve and not more than 12 percent passing a No. 200 sieve.

1. Locations: All on site fill areas

C. Structural Fill: On-site soils free of organic material, topsoil, miscellaneous fill, debris and rock fragments in excess of 3 inches in their largest dimension may be suitable as structural fill. The granular on-site soils may be suitable for re-use as structural fill. Some of these soils have an in-situ moisture content that exceeds the typical range that would allow the recommended compaction to be achieved. Therefore, drying of these soils may be required to achieve the recommended compaction.

If sufficient quantities of suitable on-site soils are not available for structural fill, imported borrow consisting of predominately granular soils conforming to the requirements of the Delaware Department of Transportation Standard Specifications Select Borrow, Type G should be utilized or AASHTO SP-57 stone.

D. Drainage fill:

1. Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel, (ASTM D 448 Coarse - aggregate grading size 57), with 100% passing of 1-1/2" sieve and not more than 5% passing a No. 8 sieve. Aggregate shall meet DELDOT specification for No. 106A aggregate. Provide by Contractor from off site source.
 - a. Locations: All concrete slab on grade areas
2. For foundation drainage, use aggregate meeting DELDOT specification for No. 113 aggregate.
 - a. Locations: Drainage fill behind basement walls and retaining walls.

- E. Stone Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, reclaimed concrete, and natural or crushed sand (ASTM D2490) with at least 95% passing a 1 ½" sieve and not more than 8% passing a No. 200 sieve. Provide by contractor from off site sources.
- F. Subbase Material: Designation CR-6 in accordance with DELDOT Specifications.
 - 1. Locations: All vehicular traffic areas
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1 inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve. For utility installations, bedding shall conform to AASHTO #57 stone.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; AASHTO M-43, size No. 17.
- I. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- J. Processed Rubble Fill: Existing brick and concrete rubble, free of wood and steel may be processed by use of tracked equipment such that no particle size greater than 6 inches in the longest dimension remains.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 FILL AND BACKFILL FOR UTILITIES

- A. Backfill: Earth removed from the trench provided that in the opinion of Soils Engineer such excavated material is satisfactory for backfilling.
- B. Should the excavated material be considered unsatisfactory for backfilling, the Contractor shall remove and dispose of such unsatisfactory material and substitute, in lieu thereof, suitable material obtained from elsewhere on or off the site.
- C. Materials shall meet the requirements specified in paragraph 2.1.A above.

2.3 TOPSOIL

- A. Refer to Section 329200 Turf and Grasses.

2.4 SOIL TREATMENT - TERMITE CONTROL

- A. Emulsion soil chemicals of only water-based type. Do not use any fuel oil as a diluent.
- B. Solutions and chemicals listed and approved by EPA, USDA, and Delaware State Department of Agriculture.
- C. Chemicals used in retreatment shall also be certified and state type of chemical and rate of concentration.

2.5 ACCESSORIES

- A. Detectable Warning Tape: Acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
1. Red: Electric
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems
 5. Green: Sewer systems.

2.6 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Unless otherwise directed, shall be nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 4. Tear Strength: 56 lbf; ASTM D 4533.
 5. Puncture Strength: 56 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Unless otherwise directed, shall be 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. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 4. Tear Strength: 90 lbf; ASTM D 4533.
 5. Puncture Strength: 90 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.7 FLOWABLE FILL

- A. Stabilized flowable fly ash mixture with a maximum slump of 8" and a minimum unconfined compressive strength of 100 psi used to fill construction excavations.
- B. Manufacturer: American Stone Mix or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify existing ground surfaces have been stripped of topsoil, root mat and existing pavement, unsatisfactory soils, concrete spoil, obstructions and deleterious material.
- B. Following rough grading and prior to foundation excavation, placement of fill, or construction of the floor slabs, it is recommended that the exposed subgrade be proofrolled. The proofroll should be performed using a minimum 10-ton vibratory roller in the presence of the qualified soils technician working under the supervision of a geotechnical engineer. Yielding or otherwise unsuitable subgrade conditions encountered within the proposed building areas should be undercut to firm subgrade conditions and backfilled with compacted structural fill.
- C. Locate underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Contact "Miss Utility".
- D. Use of explosives will not be permitted, unless approved by Owner in writing and Regulatory Agencies having jurisdiction.
- E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- F. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- G. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- H. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 EXCAVATION

- A. Excavation consists of removal and disposal of material encountered when establishing required finish grade elevations.
- B. Unauthorized Excavations:
 - 1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of A/E. Unauthorized excavation, as well as remedial work directed by A/E, shall be at Contractor's expense.
 - 2. Under footings, foundations, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing to excavation bottom, without altering required top elevation. Lean concrete, flo-ash fill, or compacted structural fill may be used to bring elevations to proper position, when acceptable by A/E.
- C. Additional Excavation: When excavation has reached required subgrade elevations, notify Soils Engineer who will make an inspection of conditions.

1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated materials as directed by A/E
 2. Removal of unsuitable material below the subgrade elevation and its replacement as directed will be paid by the Owner on basis of contract conditions relative to change in work.
- D. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of materials excavated.
1. Maintain sides and slopes of excavations in safe conditions until completion of backfilling.
- E. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition.
1. Establish requirements for trench shoring and bracing to comply with local, State & Federal codes and authorities having jurisdiction.
 2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- F. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Excavations shall be kept free of water for a minimum of two (2) inches below subgrade of excavation. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 2. Convey water removed from excavations and rain water into approved sediment control devices. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
 3. Excessive groundwater conditions: Refer to Article 4.3.6 of the General Conditions.
- G. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
1. Prevent saturation of soil above the optimum moisture content.
 2. Locate and retain soil materials away from edge of excavations.
 3. Dispose of excess soil material and waste materials as herein specified.
- H. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. If in excavating for building foundations the soil directly below the building foundations is disturbed, the disturbed soil shall be removed and shall be recompact to 95% compaction or replaced with concrete backfill.
- I. Excavation for Stone and Concrete Pavements: Cut surface under pavements to comply with cross sections, elevations and grades as shown:
 1. Where rock or concrete spoil is encountered, carry excavation 18" below subgrade and backfill with suitable material approved by the A/E.
 - J. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed with ample working room.
 1. Excavate trenches to depth, lines, gradients, and elevations indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze ups.
 2. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
 3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 - a. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - b. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 4. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing. Concrete is specified in Division 3.
 5. Do not backfill trenches until tests and inspections have been made and backfilling authorized by A/E. Use care in backfilling to avoid damage or displacement of pipe systems.
 - K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F. (1 degree C.).
 - L. Ground Surface Preparation (Structural and Pavement areas):
 1. The existing ground surface in the structural and pavement areas shall be stripped of topsoil, root mat, existing pavements, unsatisfactory soils, concrete spoil, obstructions and deleterious material. Base course material from the existing pavements may remain if approved by the A/E. The entire area shall be proof rolled, a minimum of four (4) passes, with a loaded dump truck with a minimum axle load of 10 tons in the presence of the soils engineer. Soft spots identified by the Soils Engineer during proofrolling will be undercut and backfilled in accordance with Section 3.4. Proofrolling and compaction equipment shall meet the requirements of Section 3.3.D. Undercutting and backfilling

operations for eliminating soft spots above the subgrade elevation shall be included in the base bid.

2. In cut areas, prior to the construction of paving or concrete slab on grade, the entire subgrade shall be proofrolled in the presence of the Soils Engineer. Soft areas encountered during proofrolling shall be undercut and backfilled in accordance with section 3.4. Proofrolling and compaction equipment shall be in compliance with Section 3.3 D. The cost of undercutting and backfilling above the subgrade elevation shall be included in the base bid.

M. Earthwork Quantities:

1. Contractor shall be responsible for determining earthwork quantities for the completion of the work.

3.3 COMPACTION

A. General: Control soil compaction during construction providing percentage of dry density specified for each area classification.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of the maximum dry density which is determined in accordance with ASTM D 1557, or in accordance with ASTM D 2049 for soils which will not exhibit a well defined moisture density relationship.

1. Structural, pavement and walkway areas, steps and utility trenches - 95% of the maximum dry density.
2. Lawn areas outside the designated structural fill limits – minimum compaction 90% of the maximum dry density.

C. Moisture Control: Obtaining a uniformly high degree of compaction requires control over the moisture content of the material being placed in the fills and backfill. The soils used in fill and backfill shall be brought to within 3% of optimum moisture at no additional cost to the Owner.

1. Where the soil layer is too dry, the Contractor shall apply water uniformly using approved equipment to increase the moisture content to within 3% of the optimum, taking precautions to prevent free water from appearing on the surface during or subsequent to compaction operations.
2. Where the soil layer is too wet, the Contractor shall dry the soils by plowing or discing to aerate the soil and reduce the moisture content to within 3% of the optimum.

D. Compaction equipment shall be as required to complete the scope of work outlined in the geotechnical report, contract documents and specifications for this project.

3.4 BACKFILL AND FILL

A. General: Place acceptable soil material in layers not more than eight (8) inches in thickness to required subgrade elevations, for each area classification listed below. Each layer shall be compacted to the requirements of Section 3.3B.

1. Fill and backfill within building and pavement limits and in utility trenches shall be structural fill soils meeting the requirements of Section 2.1.A.

2. Under lawn areas outside the designated structural fill limits, backfill and fill soils shall be soils meeting the requirements of Section 2.1.A, or other on site materials approved by the Geotechnical Engineer.
 3. Fill and backfill located below walkways and steps shall be constructed of structural fill soils meeting the requirements of Section 2.1.A.
 4. Drainage fill material shall be proof rolled to a uniform stable condition prior to placement of vapor retarder.
 5. Stone base course shall be compacted to 95% maximum dry density per ASTM D-1557.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Acceptance of construction below finish grade including, where applicable, subdrainage damp proofing, waterproofing, and perimeter insulation.
 2. Concrete and masonry have cured 28 days and is adequately braced.
 3. Inspection, testing, approval, and recording locations of underground utilities.
 4. Removal of concrete formwork.
 5. Removal of trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- C. Ground surface preparation: Shall be in accordance with Section 3.2K.
1. When existing ground surface has density less than that specified under Section 3.3B for particular area classification, break up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum dry density.
- D. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth, for material compacted by heavy compaction equipment and not more than 4" in loose depth for material compacted by hand operated tampers.
1. Before compaction, moisten or aerate each layer as may be necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density for each classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
 3. Structural fill shall extend a minimum of five (5) feet beyond building and road pavement limits and shall include the support slopes to their full width.
 4. Backfilling against pipe structures, whose joints involve the use of cement mortar or other concrete, or where buttresses are constructed, shall not be done until mortar has set at least 12 hours.
 5. Compaction over one foot above the pipe shall be done with approved mechanical tampers. Compaction density shall be as specified in Section 3.3.
- E. Utility trench backfill
1. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. Carefully compact material

- under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
2. Coordinate backfilling with utilities testing.
 3. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
 4. Fill voids with approved backfill materials while shoring, bracing, and sheeting is removed.
 5. Place and compact final backfill of satisfactory soil material to final subgrade.
 6. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.5 ROUGH GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces with specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades. In fill areas, sloped surfaces steeper than 5 horizontal to 1 vertical shall be benched so that fill materials will be placed on a level surface. All fill subgrades shall be observed by the Geotechnical Engineer.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 2" above or below required subgrade elevations.
 2. Walks: Shape surface or areas under walks to line, grade and cross section, with finish surface not more than .04' above or below required subgrade elevation.
 3. Pavements: Shape surface areas under pavement to line, grade and cross section, with finish surface not more than .04' for bituminous surfaces and 08' for stone surfaces, above or below required subgrade elevation.
- C. Grading Surface or Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of .02' when tested with a 10' straightedge.

3.6 BUILDING SLAB BASE COURSE

- A. General: Slab base course consists of placement of drainage fill or stone base course material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing: Place slab base course on prepared subgrade in layers of uniform thickness, conforming to indicate cross section and thickness. Maintain optimum moisture content for compacting material during placement operations.
 1. When a compacted drainage course is shown to be 6" thick or less, place material in a single layer. Where shown to be more than 6" thick, place material in equal layers, except no single layers more than 6" or less than 3" in thickness when compacted.

- C. Any ruts or soft yielding spots which may occur or any areas having inadequate compaction or deviations from the requirements set forth herein shall be corrected by removing and adding uniformly graded crushed stone or by loosening crushed gravel, reshaping and recompact. The subgrade shall have a uniform density throughout its entire depth and width and shall be approved by the A/E prior to pouring any concrete.
- D. Following this preparation, the subgrade shall be protected from damage as described below:
 - 1. The subgrade shall be protected from damage by heavy loads or equipment moving on tracks or cleats.
 - 2. The contractor shall at all times keep the subgrade drained.
 - 3. No concrete shall be deposited upon a frozen subgrade nor, until the subgrade has been approved by the A/E.
 - 4. Immediately in advance of placing concrete, the subgrade shall be sprinklered with as much water as it can readily absorb.

3.7 FINISH GRADING & PLACING TOPSOIL

- A. Refer to Specification Section 329200 – “Turf and Grasses”

3.8 MAINTENANCE

- A. Protection of graded areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re establish grades in settled, eroded and rutted areas to specified tolerances.
- B. Reconditioning compacted areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- C. Restore areas previously occupied by stockpiled materials to match finished condition of the remainder of the work.

3.9 APPLICATION OF SOIL TREATMENT

- A. Refer to Section 313116 Termite control

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials including trash, debris, and unsuitable and excess excavated material, and dispose of off Owner's property.

3.11 FIELD QUALITY CONTROL – SOILS

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.
 - 1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2922 and D-3017(shallow depth nuclear method), as applicable.
 - 2. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2,000 sq.

ft. of overlaying building slab or paved area, but in no case less than 2 tests. Field density tests shall be made at all walkway entrances and ramps into the proposed building.

3. Foundation Wall Backfill: Take enough field density tests to ensure backfill is being properly compacted.
4. Utility Trench Backfill: Perform field density tests on a spot-check basis to assist the Contractor in determining if compaction is in accordance with the specifications.
5. If in opinion of A/E, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.
6. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent evaluation and approval of each footing subgrade should be performed by Geotechnical Testing Agency.
7. Costs of testing and inspection shall be borne by the Contractor.

3.12 FIELD QUALITY CONTROL - SOIL TREATMENTS

- A. Pay costs for required testing of termite control materials. Samples shall be taken and analyzed by an independent testing laboratory.
- B. Sampling: Test one sample of working solution for each 10,000 square feet of area applied. Take samples from discharge end of spraying equipment for each batch mixed and applied if less than 10,000 square feet.
- C. Retreating: Retreat all areas if the test results average less than 90 percent of listed minimum concentration.

3.13 TESTING AND INSPECTION

- A. INSPECTION AGENCY: Contractor shall employ an Independent Testing agency for purposes of inspecting and testing construction of embankments, fills, backfills, trenches, and subgrades and report to the A/E conformance in all particulars to specification requirements.
- B. Scheduling:
 1. Assign qualified personnel to be on site at all times when operations are scheduled.
 2. The Contractor should note that no earthwork operation shall be permitted in their absence.
- C. Responsibilities:
 1. Evaluation of subgrade preparation and suitability.
 2. Moisture content and field density tests on all layers of fill and backfill material placed.
 3. Evaluation of degree of compaction attained for all fill and backfill material placed.
 4. Testing and evaluation of borrow material.
 5. Sources of borrow and of select fill.
 6. Footing subgrade suitability.
 7. Inspection of installation of Subdrainage system.
- D. Results of Tests:

1. Make results available to the Soils Engineer and A/E immediately upon completion of areas of layers.
- E. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project. A discussion of all deviations from the contract documents and specifications, with their related impact on the final construction, shall be described in detail. The engineer of record shall review this final report, and recommend corrective measures (as deemed necessary) that must be made prior to final acceptance of the work. Prior to final payment, a written report certifying that the work meets the requirements of the contract documents, specifications, and all governing agencies shall be prepared, submitted, and approved by the A/E.

END OF SECTION 312000

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SECTION 312319 - DEWATERING

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 construction dewatering.
- B. The Contractor is required to provide for sufficient costs during bidding to address dewatering needs that occur during the specified scope of work of the project.
- C. Related Sections include the following:
 - 1. Division 01 Section "Temporary Construction Utilities, Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading and for site utilities.
 - 3. Division 31 Section "Excavation Support and Protection."

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. 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.
 - 2. Prevent surface water from entering excavations by grading, dikes, well pointing or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Construction Manager and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 - 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, 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 Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare application, and any necessary analysis including Hydro-Geo investigation and reports, and obtain necessary permits from DNREC prior to dewatering activity.
- B. 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.
- C. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, 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.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 - 1. Remove dewatering system from Project site on completion of dewatering.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed, in compliance with Delaware and other applicable regulations.

END OF SECTION 312319

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SECTION 313116 - TERMITE CONTROL

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. Soil and wood treatment with termiticide.

B. Related Sections:

- 1. Division 06 Section "Rough Carpentry" for wood preservative treatment by pressure process.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of termite control product.

- 1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For termite control products, from manufacturer.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

- 1. Date and time of application.
- 2. Moisture content of soil before application.
- 3. Termiticide brand name and manufacturer.
- 4. Quantity of undiluted termiticide used.
- 5. Dilutions, methods, volumes used, and rates of application.
- 6. Areas of application.
- 7. Water source for application.

D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Termiticide brand name and manufacturer.
3. Quantity of undiluted termiticide used.
4. Dilutions, methods, volumes used, and rates of application.
5. Areas of application.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.
- B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.
- C. Source Limitations: Obtain termite control products from single source.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
- B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.
- C. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
- D. Install polymer sheet barrier system with termiticide prior to placing concrete slab reinforcement and pouring concrete and after installation and inspection of footings, foundations, and plumbing and electrical pipes and conduits.
- E. Install polymer barrier fittings with termiticide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical pipes and conduits, slab vapor barrier, and concrete slab reinforcement.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is

discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

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

B. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied wood termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.

1. Warranty Period: 12 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. BASF Corporation, Agricultural Products; Termidor.
- b. Bayer Environmental Science; Premise 75.
- c. FMC Corporation, Agricultural Products Group; Dragnet FT.
- d. Syngenta; Demon TC.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 - 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
 - 1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases;

- and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspace: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 4. Masonry: Treat voids.
 5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- D. Post warning signs in areas of application.
- E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

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SECTION 315000 - EXCAVATION SUPPORT AND 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 temporary excavation support and protection systems.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Construction Utilities, Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 31 Section "Earth Moving" for excavating and backfilling and for existing utilities.
 - 3. Division 31 Section "Dewatering" for dewatering excavations.

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil, hydrostatic pressure, superimposed and construction loads.
 - 1. Contractor is solely responsible for maintenance of excavations and worker safety. Architect, Owner and Construction Manager bear no liability for excavation support and protection systems.
 - 2. Provide professional engineering services needed to assume engineering responsibility where required, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.4 SUBMITTALS

- A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
 - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For Installer and professional engineer.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 - 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, 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.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

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SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Warm-mix and hot-mix asphalt paving.
2. Warm-mix and hot-mix asphalt patching.
3. Warm-mix and hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking materials.
6. Cold milling of existing hot-mix asphalt pavement.

- B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

- A. Warm-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- C. DOT: Delaware Department of Transportation.

1.4 SYSTEM DESCRIPTION

- A. Provide warm-mix (WMA) and hot-mix (HMA) asphalt paving according to materials, workmanship, and other applicable requirements of Specifications for road and Bridge Construction of the Delaware Department of Transportation.
 1. Standard Specification: Division 400; including all updates.
 2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Job-Mix Designs: For each job mix proposed for the Work.

- D. Qualification Data: For manufacturer.
- E. Material Test Reports: For each paving material.
- F. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer.
 - 1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Testing Agency Qualifications: Construction Manager or Owner will engage a Qualified Testing agency Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.
- C. Regulatory Requirements: Comply with Delaware Department of Transportation Specifications for Road and Bridge Construction for asphalt paving work.
- D. All paving section materials, striping and signage shall be as outlined in the DE MUTCD.
- E. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to WMA and HMA asphalt paving including, but not limited to, the following:
 - 1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture WMA and HMA asphalts.
 - 2. Review condition of subgrade and preparatory work.
 - 3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp. Adhere to all specifications in Delaware Department of Transportation Specifications for Road and Bridge Construction.
- B. Pavement-Marking Paint, Epoxies and Thermo-Plastics: Proceed with pavement marking only on clean, dry surfaces and at minimum ambient or surface temperatures specified in the Delaware Department of Transportation Specifications for Road and Bridge Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials: All materials used under this section shall conform to the requirements of Delaware Department of Transportation Specifications for Road and Bridge Construction and the Delaware Manual on Uniform Traffic Control Devices (MUTCD), including, but not limited to: graded aggregate, asphalt cement, tack coat and traffic control devices.
- B. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid or wettable powder form. Obtain written approval from the Maryland Department of the Environment prior to application of the herbicide.
 - 1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - a. Ciba-Geigy Corp.
 - b. Dow Chemical, USA
 - c. E.I. Du Pont de Nemours & Co., Inc.
 - d. FMC Corp
 - e. Thompson-Hayward Chemical Co.
 - f. U.S. Borax and Chemical Corp.
 - g. Allied Chemical Corp.
 - h. Ag-Chem Products, Inc.
- C. Thermoplastic, epoxy and other types of lane marking materials for WMA, HMA and concrete surfaces shall comply with Division 700 of the Delaware Department of Transportation Specifications for Road and Bridge Construction; and the Delaware Department of Transportation, Striping Item Guidelines.
 - 1. Color: White
 - 2. Color: Yellow
 - 3. Color: Blue
- D. Joint Sealants: Joint Sealants shall comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Divisions 700 & 800.

2.2 MIXES

- A. WMA and HMA Asphalt: Provide Plant Mixed, hot-laid, asphalt-aggregate mixture complying with Delaware Department of Transportation Specifications for Road and Bridge Construction, Division 400 and referred Divisions.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with if formulated by manufacturer for that purpose.
 - 2. Remove spillages and clean affected surfaces.
- D. Proceed with paving only after unsatisfactory conditions have been corrected.
- E. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at a rate of 0.05 to 0.15 gal. Per sq. yd. of surface in accordance Section 401 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.
- F. Allow to dry until at proper condition to receive paving.
- G. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of as specified on plans.
 - 2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
 - 3. Control rate of milling to prevent tearing of existing asphalt course.
 - 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 - 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 - 6. Transport milled hot-mix asphalt to asphalt recycling facility.
 - 7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

- A. WMA and HMA Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
 - 1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseal pieces firmly.
 - 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
- E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
 - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
 - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
 - 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 ASPHALT PLACING

- A. Machine place WMA and HMA asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place WMA and HMA asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place WMA and HMA asphalt surface course in single lift.
 - 3. Spread HMA mix at minimum temperature of 225 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Immediately correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
- D. Place final paving course after receiving written approval of Construction Manager or Owner.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course. Joints shall comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Section 401.12.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.

- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 98 percent of reference laboratory density according to AASHTO T 209, but not less than 96 percent nor greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Owner, and DelDOT where jurisdiction applies.

- B. Contractor shall provide striping on parking and roadway surfaces as indicated on the plans. The following is a list of included, but not necessarily all, striping:
 - 1. Parking stalls.
 - 2. Cross-hatch/gore areas.
 - 3. Handicap Parking symbols.
 - 4. Stop bars.
 - 5. Directional arrows.
 - 6. Lane lines.
 - 7. Words/numbers.
- C. Allow paving to age for 30 days before starting pavement marking.
- D. Sweep and clean surface to eliminate loose material and dust.
- E. Apply paint, where called for, with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Broadcast glass spheres, where called for, uniformly into wet pavement markings at a rate of 6 lb/gal. for all markings with the exception of parking stall lines.
- F. All other paving markings shall be installed per DOT regulations including Division 700 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Construction Manager or Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken. Owner may choose to forgo some or all core samples on a case by case basis.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
 - c. Contractor required to repair all testing locations.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 321216

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways and roadways.
 - 2. Parking lots.
 - 3. Curbs and gutters.
 - 4. Walkways.
 - 5. Truncated domes.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
 - 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Concrete; mix and supplier information.
 - 2. Truncated domes.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Samples: 10-lbsample of exposed aggregate.
- D. Qualification Data: For manufacturer. Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

- E. Material Test Reports: Contractor will engage a qualified testing agency for indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or epoxy adhesive.
 - 8. Joint fillers.
- G. Field quality-control test reports.
- H. For plazas and wide walkways, submit control joint spacing plan for review.
- I. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: Construction manager or Owner will engage An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.

2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Owner and not less than 96 inches by 96 inches
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete producer.
 - d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
1. Use flexible or curved forms for curves with a radius 100 feet or less.

- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.
- F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- H. Plain Steel Wire: ASTM A 82, as drawn.
- I. Deformed-Steel Wire: ASTM A 496.
- J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.
- K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.
- M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- O. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

- P. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

- A. Materials: All materials including but not limited to reinforcing materials, concrete materials, concrete mix, admixtures, curing materials, traffic paint and other related materials used under this section shall conform to the requirements of the Delaware Department of Transportation Specifications for Road and Bridge Construction. References to a required class of concrete shall correspond to the classes as shown in the State of Delaware Department of Transportation Specifications for Road and Bridge Construction Division 500 and Division 800.
- B. Fly ash shall meet the approval of the ASTM C-618 pozzolan Class F and may be used as a partial substitute for cement when approved by the Owner.
- C. The concrete mix used in performing this work shall be DelDOT Class "A" or DelDOT Class "B" depending on the compressive strength shown on the details and shall meet the approval of the Owner.
- D. The concrete temperature shall not exceed 90°F when delivered to the job-site or at any time prior to placement in the forms.
- E. Type I - Portland Cement: Shall be used from October 1 through May 1 and when the air temperature in the shade and away from artificial heat is above 70°F or less, or as directed by the Owner.
- A. Type II - Portland Cement: Shall be used from May 1 through October 1 and when the air temperature in the shade and away from artificial heat is above 70°F, or as directed by the Owner.
- F. When approved by the Owner, Hi-Early strength concrete may be used. Approval will be on a case by case basis.
- G. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
 - 1. Aggregate Sizes: 1/2 to 3/4 inch nominal.
 - 2. Aggregate Source, Shape, and Color: Submit color samples for review by Owner.
- H. Water: ASTM C 94/C 94M.
- I. Air-Entraining Admixture: ASTM C 260.
- J. Chemical Admixtures: Admixtures may only be use with prior approval by the Owner. Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
 1. Available Products:
 - a. Fibrillated Fibers:
 - 1) Axim Concrete Technologies; Fibrasol F.
 - 2) FORTA Corporation; Forta.
 - 3) Euclid Chemical Company (The); Fiberstrand F.
 - 4) Grace, W. R. & Co.--Conn.; Grace Fibers.
 - 5) SI Concrete Systems; Fibermesh.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
 1. Available Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edeco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, ChemRex Inc.; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation; Finishing Aid.
 - p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

1. Available Products:

- a. Anti-Hydro International, Inc.; AH Curing Compound #2 WP WB.
- b. Burke by Edoco; Resin Emulsion White.
- c. ChemMasters; Safe-Cure 2000.
- d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
- e. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
- f. Euclid Chemical Company (The); Kurez VOX White Pigmented.
- g. Kaufman Products, Inc.; Thinfilm 450.
- h. Lambert Corporation; Aqua Kure-White.
- i. L&M Construction Chemicals, Inc.; L&M Cure R-2.
- j. Meadows, W. R., Inc.; 1200-White.
- k. Symons Corporation; Resi-Chem White.
- l. Tamms Industries, Inc.; Horncure 200-W.
- m. Unitex; Hydro White.
- n. Vexcon Chemicals, Inc.; Certi-Vex Enviocure White 100.

2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: (For exposed aggregate concrete) Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Products:

- a. Burke by Edeco; True Etch Surface Retarder.
- b. ChemMasters; Exposee.
- c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
- d. Euclid Chemical Company (The); Surface Retarder S.
- e. Kaufman Products, Inc.; Expose.
- f. Metalcrete Industries; Surfard.
- g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
- h. Scofield, L. M. Company; Lithotex.
- i. Sika Corporation, Inc.; Rugasol-S.
- j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.8 WHEEL STOPS

- A. Wheel Stops: Solid, 3000 PSI concrete, precast.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.9 ADA TRUNCATED DOMES

- A. General: In-line replacable designed to be installed in a “wet set” condition. Units must include anchors which allow replacement by removing colored covers and bolts while leaving anchors in place.
- B. Materials: Homogenous glass and carbon reinforced composite
 - 1. UV stable and colorfast.
 - 2. Resistant to salt and chemical staining per ASTM B 117 & 1308.
 - 3. Minimum Compressive and Tensile Strength of 28,900 psi and 11,600 psi respectively.
 - 4. Must be able to handle load bearing capacity of 16,000 lbs per AASHO –H20 with no visible damage.
 - 5. Color must be uniform throughout with no paint or coating to provide color.
 - 6. Dome geometry must comply with ADA regulations for detectable warnings at curb ramps in diameter, height and spacing.
- C. Where installation on radius is shown, provide precut and scored units for installation without gaps and piecemeal infills. Field cut rectangular units will not be acceptable.
- D. Units shall be by ADA Solutions, Inc. or approved equal.

2.10 CONCRETE MIXTURES

- A. The concrete mix used in performing this work shall be DelDOT Class “A” or DelDOT Class “B” depending on the compressive strength shown on the details and shall meet the approval of the Owner.
- B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- C. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi or 3000 psi. depending on location
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 2-5, plus or minus 1 inch.
- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture, plasticizing and retarding admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- G. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. Limits shall be as follows per DelDOT requirements:
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- H. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd..

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116 where synthetic fibers are noted on the plans. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.12 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952.
 - 1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 20 feet, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. All Isolation Joints shall be treated with joint filler.
 - 4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. For larger walkways, width greater than 12' and plazas, submit shop drawing of joint pattern. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - 2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed pavement surfaces with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
- K. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

- N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Construct test sections of each type of concrete paving, including at least one expansion joint and control joints, for review by Owner for agreement of finish prior to starting concrete installation. Review will include texture of broom finish, joint striking, picture framing and geometric conformity.
 2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 3. Incorporate "picture framing" of concrete in finish within lump sum prices bid.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. 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.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 WHEEL STOPS

- #### A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- #### A. Testing Agency: Construction Manager shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

- #### B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Owner.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by Owner, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

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SECTION 321373 - CONCRETE PAVING 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. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
- B. Related Sections include the following:
 - 1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 REQUIREMENTS

- A. Work within DeIDOT R.O.W. shall comply with the Delaware Standard Specifications for Road and Bridge Construction August 2001, including all updates.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F .
2. When joint substrates are wet or covered with frost.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

- A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
 1. Products:
 - a. Crafcoc Inc.; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of backer materials.
 2. Do not stretch, twist, puncture, or tear backer materials.
 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses provided for each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealants from surfaces adjacent to joint.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 323119 - DECORATIVE METAL FENCES AND GATES

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. Decorative horizontal slat aluminum fencing.
- 2. Swing gates.

B. Related Requirements:

- 1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for concrete post concrete fill.

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: For fencing and gates.

- 1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details.

- C. Samples: For each fence material and for each color specified.

- 1. Provide Samples 12 inches (300 mm) in length for linear materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

- B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
1. Include minimum 10-foot (3-m) length of fence complying with requirements.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Wind Loading:
1. Fence Height: 0 to 15 feet (0 to 4.57 m).
 2. Wind Exposure Category: B.
 3. Design Wind Speed: 105 mph (169 kph).

2.2 DECORATIVE ALUMINUM FENCES

- A. Decorative Aluminum Fences: Fences made from aluminum extrusions.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Al Seiko Fence Factory.
 - b. Stratco.
 - c. The Fence King.
- B. Basis of Design: Horizontal aluminum slat fencing by The Fence King.
- C. Fence height: As indicated.
- D. Posts: Square extruded tubes.
1. Posts: Manufacturer's standard recommended sizes.
- E. Post Caps: Aluminum castings that cover entire top of posts.
- F. Aluminum Slat Infills: 65mm.

- G. Fasteners: Manufacturer's standard concealed fastening system.
- H. Finish: Baked enamel or powder coating.

2.3 SWING GATES

- A. Gate Configuration: Double leaf.
- B. Gate Frame Height: As indicated.
- C. Gate Opening Width: 72 inches (1829 mm).
- D. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes sized as recommended by manufacturer.
- E. Infill: Comply with requirements for adjacent fence.
- F. Hardware: Fully lockable and self-closing hinges.
- G. Aluminum Finish: Baked enamel or powder coating.

2.4 ALUMINUM

- A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.
- B. Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5.
- C. Tubing: **ASTM B429/B429M**, Alloy 6063-T6.
- D. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
- E. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
- F. Castings: **ASTM B26/B26M**, Alloy A356.0-T6.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of **3000 psi (20 MPa)**, **3-inch (75-mm)** slump, and **1-inch (25-mm)** maximum aggregate size.

- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.6 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening slats to posts.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).
- D. Post Setting: Set posts in concrete into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and/or sleeves as recommended by manufacturer. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches (51 mm) above grade. Finish and slope top surface to drain water away from post.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 FIELD QUALITY CONTROL

3.6 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323119

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Execute the work of this Specification in accordance with applicable portions of;
 - 1. Division 1 – General Requirements
 - 2. Drawings L-101

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Meadow grasses and wildflowers.
- B. Related Sections:
 - 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Division 32 Section "Landscape" for plantings.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. 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.

1.4 EXTERNAL DOCUMENTS

- A. The Delaware Erosion and Sediment Control Handbook; 2005 Update. Available at <http://www.dnrec.delaware.gov>.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.6 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture to be utilized for the project. Include identification of source and name and telephone number of supplier.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Material Test Reports: For existing in-place surface soil and imported topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
 5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for lime, nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Pre-installation Conference: To Be Announced

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Sod: (Not Used).
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance.
 - 1. Spring Planting: March 15 – June 15
 - 2. Fall Planting: September 15 – November 15
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.10 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Seeded Turf: 90 days from date of installation.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 - 2. Sodded Turf: (Not Used)
- B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 90 days from date of installation.

- C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

- 2.1 All materials shall comply with the Delaware Erosion and Sediment Control Handbook; 2005 Update. Available at <http://www.dnrec.delaware.gov>.

2.2 TEMPORARY STABILIZATION SEED

- A. Grass Seed: Mix no. 5 (annual ryegrass) in accordance with detail de-esc-3.4.3, sheet 1 of 4 within the Delaware Erosion and Sediment Control Handbook.
- B. Seed Species: Annual Ryegrass. Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. All areas: Annual Ryegrass (*Lolium temulentum*).
 - 2. Apply at 125#/acre.
 - 3. Planting depth, 0.5 inches.

2.3 PERMANENT GRASS SEED

- A. Apply mix No. 7 in accordance with DE-ESC-3.4.3, sheet 2 of 4 within the Delaware Erosion and Sediment Control Handbook.
 - 1. All areas: Mix No. 7
 - 2. Apply at 150 #/acre.

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 85 percent calcium carbonate, ground so that not less 90% passes a 10 mesh sieve and not less than 30% passes a 100 mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.

- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through ½ inch sieve; soluble salt content of 4 to 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

2.6 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
 - 3. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual

nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

2.7 PLANTING SOILS

A. TOPSOIL

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.

Soil sample tests will be ordered by the Landscape Architect and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	<u>Passing %</u>	<u>Retained %</u>
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in all plant beds, pit plantings, ground cover areas, and lawns or as called for on the drawings whichever is greater.

B. LIGHT WEIGHT ON-STRUCTURE PLANTING SOIL (NOT USED)

2.8 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Hardwood Bark Mulch (Shredded).

1. Shredded Hardwood Bark Mulch made of various hardwoods, mostly Oak, is ground (hammer milled) through a screen to provide a shredded, fibrous material. This is coarse mulch with large pieces down to fines. The pH shall range between 6 and 7.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content 2-5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content 50-60 percent of dry weight.
 2. Feedstock: (NOT USED).
- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.9 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.10 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples,

- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface,. Include manufacturer's recommended anchorage system for slope conditions.

2.11 GRASS-PAVING MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.

- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil off-site before spreading.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of as noted on plans.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with [fiber-mulch manufacturer's recommended tackifier.
 - 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 TURF RENOVATION

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Apply seed and protect with straw mulch as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.8 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
- D. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over and bare spots not exceeding 5 by 5 inches .
 2. Satisfactory Sodded Turf: (Not Used).
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 – LANDSCAPE

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. Execute the work of this Specification in accordance with applicable portions of:

1. Division 1 - General Requirements
2. Drawings L-101.

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:

1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 32 Section "Turf and Grasses" for turf (lawn), sod (alternate to bid) and meadow planting, hydro-seeding, and erosion-control materials.

1.3 ALLOWANCES

A. Allowances for plants are specified in Division 01 Section "Allowances."

1. Perform planting work under quantity allowances and only as authorized. Authorized work includes: Unless specifically excluded hereinafter under RELATED SECTIONS: provide labor, materials, equipment and services necessary and incidental to complete work described by this Section's title shown above. Work includes, but is not necessarily limited to:
 - a. Fine Grading.
 - b. Providing and Placing all Off-site Topsoil and Planting Soil Backfill Mix required to complete Landscape Development Work.
 - c. Preparation of Planting Areas as required.
 - d. Furnishing and installing all Plant Material.
 - e. Furnishing and installing all Shredded Hardwood Bark Mulch
 - f. Maintenance of all Work until Final Acceptance (not less than 60 days).
 - g. Clean-up of Work Area as outlined in these specifications.
2. Notify Landscape Architect weekly of extent of work performed that is attributable to quantity allowances.
3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

1.4 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."
 - 1. Unit prices apply to authorized work covered by quantity allowances.
 - 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.5 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- H. Finish Grade: Elevation of finished surface of planting soil.
- I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- K. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- L. Planting Area: Areas to be planted.
- M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- R. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- S. 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.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Pesticides and Herbicides: Include product label and manufacturer's application instruction specific to the Project.
 - 3. Plant Photographs: Include color photographs in either digital or 3- by 5-inch (76- by 127-mm) print format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
 - 1. Trees and Shrubs: Contact Landscape Architect for review of plant material, based on information received above in product data. The Landscape Architect reserves the right to inspect trees and shrubs either at place of growth or at site before planting, for compliance with requirements for name, variety, size and quality. Provide trees and shrubs grown in a recognized nursery in accordance with good horticultural practice. Provide healthy, vigorous stock grown under climatic conditions similar to conditions in the locality of the project and free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions or disfigurement. Provide trees and shrubs of the sizes shown as specified. Trees and shrubs of larger size may be used, if acceptable to Landscape Architect, and if sizes of roots or balls are increased proportionately.
 - 2. Mulch: one-quart volume of each organic mulch required, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 3. Filter Fabric: 12 x12" sample, with manufacturer specifications.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualifications: The Landscape Work shall be done by a single firm specializing in landscaping work. Include list of similar projects completed, demonstration Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulation applicable to landscape materials.
 - 2. Manufacturer's certified analysis of standard products.
 - 3. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Material Test Reports:

- 1. Certification: For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturers or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.
- D. Maintenance Instructions: Maintenance Instructions: Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one full year. Submit prior to expiration of required maintenance period(s).
- E. Provide two copies of warranty (See Item 1.11 for specific requirements).
- F. Schedule of Work: For information only, submit 3 copies of tentative schedule to Owner and/or Owner's Agent along with Landscape Architect. Contractor shall keep all parties above apprised of any changes so that the Owner's Agent is aware of scheduled work at least 24 hours prior to said work being started.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

- 1. Provide Professional Memberships.
- 2. Provide number of years' experience in Landscape Installation in addition to requirements in Division 01 Section "Quality Requirements"
- 3. Provide Field Supervision Installers experience. Note full-time Supervisor to be on Project Site at all times when landscape installation is in progress.
- 4. Pesticide Applicator: Licensed

B. Provide Soil-Testing Laboratory Name and Qualifications.

C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil testing laboratory stating percentages of organic matter, gradation of sand, silt, and clay content; cation exchange capacity, deleterious material, pH, and mineral and plant nutrient content of the soil.

- 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
- 2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
- 3. Report suitability of tested soil for plant growth.
 - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq ft or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments

- to be added to produce satisfactory planting soil suitable for healthy, viable plants.
- b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. Do not make substitutions: If specified landscape material is not obtainable, submit to Landscape Architect proof of non-availability and proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.
- E. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
- 1. Notify Landscape Architect of sources of planting materials 14 days in advance of delivery to site.
- F. Hardscape Materials: Materials and methods of construction shall comply with American Society for Testing and Materials (ASTM). Installation shall be performed by skilled workmen with a satisfactory record of performance on completed projects of comparable size and quality. Do not change source of Hardscape Materials during the course of the work.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable. Protect materials from deterioration during delivery, and while stored at the site. Materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers, and soil amendments with appropriate certificates.
- C. Plant Materials:
 - 1. Bare- Root Stock: NOT USED.
 - 2. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
 - 3. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.
 - 4. Do not remove container grown stock from containers until planting time.
 - 5. Handle planting stock by root ball.
 - 6. Bulbs: NOT USED

7. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set plants and trees in their appropriate conditions, protect from weather and mechanical damage, and keep roots moist.
 - a. Set balled stock on ground and cover ball with soil, peat moss, or other acceptable material.
 - b. Do not remove container-grown stock from containers before time of planting.
 - c. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary, to maintain root systems in a moist, but not overly-wet condition.

1.10 PROJECT CONDITIONS

- A. Field Measurements: Installer must verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Installer must observe the conditions under which work is to be performed and notify the Landscape Architect of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
 1. Notify the Landscape Architect/ Construction Manager and or Owner no fewer seven days in advance of proposed interruption of each service or utility.
 2. Do not proceed with interruption of services or utilities without Construction Managers and or Owner's written permission.
- C. Planting Restrictions: Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
- D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting.
- E. Planting Schedule: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during normal seasons for such work in the area of the site. Correlate with specified maintenance periods to provide maintenance until acceptance by the Owner. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- F. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Landscape Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.
- G. Protect existing trees, shrubs and other hardscape elements against damage including trespassing, and erosion.
- H. Protect all existing plant material in the area of this contract, whether inside or outside the contract limit line, against any damage, which in the opinion of the Landscape Architect will cause death or major retardation. Such material shall be replaced with same size and species by the Contractor at no additional cost should such damage occur.
- I. Inspection of work will be made at the conclusion of work (at acceptance of the project). Submit written notice requesting final inspection at least 10 days prior to anticipated date.

1.11 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond contractor's control.
 - b. Structural failures including plantings, falling or blowing over.
 - c. Structural failures of tree stabilization structures, or stone energy dissipaters
 2. Warranty periods will begin from the Date of installation completion (as determined by the Landscape Architect for a period of 12 months (one year).
 3. Include the following remedial actions as a minimum.
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement for each plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for a period equal to the original warranty period, for replaced plant material.

1.12 MAINTENANCE

- A. All planted trees, shrubs, groundcovers and annual flowers, shall be maintained until final acceptance of the completed contract. This shall be not less than 60 days. Maintenance shall include watering, cultivating, control of insects, fungus, and other horticultural operations necessary for the proper growth of all plants.

**

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings L-101. and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with damaged, crooked, or multiple leaders (unless otherwise indicated); tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 "Standard for Nursery Stock" for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls. Provide plant materials true to name and variety established by the American Joint Committee on Horticultural Nomenclature "Standardized Plant Names," Second Edition, 1942.
- C. Deciduous Trees: Provide trees of height and caliper listed or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.
1. Provide balled and burlapped (B&B) deciduous trees.
 2. Container grown deciduous trees will be acceptable in lieu of balled and burlapped deciduous trees subject to specified limitations of ANSI Z60.1 for container stock.
- D. Deciduous Shrubs: Provide shrubs of the height shown or listed and with not less than the minimum number of canes required by ANSI 260.1 for the type and height of shrub required.
1. Provide balled and burlapped (B&B), bare root (B.R.) or container deciduous shrubs as specified in plant list.
 2. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to the specified limitations for container grown stock.
- E. Coniferous and Broadleaved Evergreens: Provide evergreens of the sizes shown or listed. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf cone, pyramidal, broad upright and columnar. Provide normal quality evergreens with well-balanced form complying with requirements for other size relationships to the primary dimension shown.
1. Provide balled and burlapped (B&B) or container grown evergreens as specified.
 2. Container grown evergreens will be acceptable in lieu of balled and burlapped evergreens subject to the specified limitations for container grown stock.
- F. Labeling: label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

- G. If formal arrangements or consecutive order of plants is shown on plans, select stock for uniform height and spread, and number the labels to assure symmetry in planting
- H. Annuals and Biennials – Optional for Client determination. Provide healthy, disease-free plants, with well- established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 INORGANIC SOIL AMENDMENTS

- A. Ground Limestone: (To be incorporated into soil if soil pH value test shows low level of soil Ph which needs to be raised.). ASTM C 602, natural limestone containing not less than 85% of total carbonates, ground so that not less 90% passes a 10-mesh sieve and not less than 30% passes a 100-mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No.6 sieve and a maximum of 10 percent passing through no. 40 sieve.
- C. Iron Sulphate: Granulated ferrous sulfate containing a minimum of 20 percent and 10 percent sulfur. (To be incorporated into soil if soil pH value test shows high level of soil pH which needs to be lowered.) Iron Sulphate shall be applied at the rate adequate to bring pH range down to 6.0 to 6.5 and as per "Cornell Recommendations for Commercial Turf Grass Management".
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2 inch sieve; soluble salt content of 4 to 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight
 - 2. Feedstock: NOT USED
- B. Peat Humus: FS Q-P-166 and with the texture and pH range OF 3.4 TO 4.8.

- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Wood Derivatives: NOT USED
- E. Manure: NOT USED

2.4 FERTILIZERS

- A. Bonemeal: Commercial, raw, or steamed, finely ground; 4% nitrogen and 20% phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, Soluble; a minimum of 20% available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.

1. For All New Trees and Shrubs:

All trees and shrubs shall be fertilized with a controlled release 16-8-16 analysis fertilizer contained in a polyethylene perforated bag with micropore holes. The bag shall contain four (4) ounces minimum of water soluble fertilizer so as to be effective for eight (8) years.

The packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

A "Certificate of Compliance" must accompany invoice showing quantity of material ordered, where material was supplied and shipped to, and its consigned route and specific job application.

- 2. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

- D. Organic Fertilizer and Soil Conditioner: All trees and shrubs shall be treated with PHC Healthy Start which contains a blend of natural organic nutrients, proteins, sugars and other carbohydrates, humic acids, biostimulants and beneficial bacteria that enrich soil.

PHC Healthy Start is available from Plant Health Care, Inc., 440 William Pitt Way, Pittsburgh, Pennsylvania, 1- 800-421-9051. (Or approved equal)

2.5 PLANTING SOILS

A. TOPSOIL

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.

Soil sample tests will be ordered by the Landscape Contractor and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	<u>Passing %</u>	<u>Retained %</u>
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in all plant beds, pit plantings, ground cover areas, and lawns or as called for on the drawings whichever is greater. 12" for annual plant beds.

B. Fill - NOT USED

C. Lightweight Or Structure Planting Soil – NOT USED

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:

1. Mulch: Shall be 100% Double Hammered Milled Shredded Hardwood Bark Mulch. Mulch shall be free from any extraneous materials and spread to a 3" depth minimum (after settlement). Contractor shall submit certification detailing content and source of mulch for Landscape Architect's approval.

2. Color: No artificial, dyes or colorant will be allowed.

B. Compost Mulch: NOT USED

2.7 WEED-CONTROL BARRIERS – NOT USED

2.8 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- 2.9 TREE STABILIZATION MATERIALS
- A. Stakes and Guys:
 - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, treated softwood with specified wood pressure- preservative treatment, free of knots, holes, cross grain, and other defects, (2" by 2" by 5'-0" min), pointed at one end, 3 per tree.
 - 2. Wood Deadmen: NOT USED
 - 3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 12 gauge.
 - 4. Guy Cables: Five-strand, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 6 inches long, with two 3/8 inch galvanized eyebolts.
 - B. Root-Ball Stabilization Materials: NOT USED
- 2.10 LANDSCAPE EDGINGS – NOT USED
- 2.11 TREE GRATES – NOT USED
- 2.12 MISCELLANEOUS LANDSCAPE MATERIALS
- A. Anti-Desiccant: Emulsion type, film-forming agent similar to Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., designed to permit transpiration, but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions. All plants shall be sprayed with an anti-desiccant once in late Fall (November) and once in late Winter (February).
 - B. Wrapping: Tree-wrap tape not less than 4" wide, designed to prevent borer damage and winter freezing.
 - C. Filter Fabric: Filter weave 40/10 as manufactured by Nicolon/Mirafi Group. (Or approved equal). Filter weave 40/10 is available from Ragen Associates. 20 Larsen Rd., Iselin, NJ 08830, (732)602-9500 or (800)752-1010 outside NJ.
 - D. Playground Equipment complying with project requirements shall be manufactured by DuraMax Structures a Playcore Company, 401 Chestnut Street, Chattanooga, TN 37402 or approved equal. (see Section 3.20).
 - E. Safety surface shall be No Fault Safety Surface as manufactured by No Fault Sport Group, LLC, 3112 Valley Creek Drive, Suite 2, Baton Rouge, LA 70808. (see Section 3.20). (Or approved equal)
 - F. No Fault Safety Tiles as are manufactured by ECORE International and sold exclusively by No Fault Sport Group, LLC and it's authorized agents, 1-866-637-7678 or www.nofault.com. Any substitutions must be approved. (see Section 3.20)

** END OF PART 2
**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

- A. Rough grade will be left 4" below finished grade by others. Loosen subgrade of lawn areas to a minimum depth of 4". Remove stones over 1" in any dimension and sticks, roots, rubbish and other extraneous matter and legally dispose them off Owner's property. Limit preparation to areas, which will be planted promptly after preparation.

1. Spread topsoil to minimum depth required to meet lines, grades and elevations shown, after light rolling and natural settlement (4" after settlement). Place approximately 1/2 of total amount of topsoil required. Work into top of loosened subgrade to create a transition layer and then place remains of topsoil. Add specified soil amendments (as per Section 3.19-B of this specification) and mix thoroughly into the upper 4 inches of topsoil.
 2. Where final grades are not indicated, finish grades shall be of uniform level or slope between points for which elevations are given or from such points to existing grades, except that tops and bottoms of banks shall be rounded. Subgrade elevations shall be understood to be the specified depth below finished grades.
 3. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before seeding. Do not create a muddy soil condition.
 4. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Leave center bottom of excavation slightly raised at center to provide proper drainage. Ensure that root ball will sit on undisturbed base soil to prevent settling. Loosen hard subsoil in bottom of excavation.
1. For balled and burlapped (B&B) trees and shrubs, make excavations at least the equivalent of two and a half times as wide as the ball radius and equal to the ball depth, plus the following allowance for setting of ball on a layer of compacted backfill: Allow for 6" setting layer of planting soil mixture.
 2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 3. Do not excavate deeper than the depth of the root ball, measured from the root flare to the bottom of the root ball.
 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 5. Maintain required angles of repose of adjacent material as show on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 6. Maintain supervision of excavations during working hours.
 7. Keep excavations covered or otherwise protected after working hours, overnight and when unattended by contractor's personnel.
- B. Subsoil and topsoil removed from excavations MAY NOT be used as planting soil.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the tip-most root emerges from the trunk. After soil removal to expose the root flare, verify that the root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots, remove injured roots by cutting cleanly; do not break.
- C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 3 inches above adjacent finished grade.
 - 1. During the placement of backfill place "Unique Fertilizer Packets" as specified in section 2.4 C as follows:

	<u>Types of Plants</u>	<u>No. of Packets</u>
a.	Trees:	
	Over 4-inch caliper	4
	1 to 4-inch caliper	3
	Over 6 feet high	4
	3 to 6 feet high	3
	15 to 36 inches high	2
	Under 15 inches high	1
b.	Shrubs:	
	Over 3 feet high	3
	2 to 3 feet high	2
	Under 2 feet high	1

The packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

- 2. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill. Remove collar ropes only. Retain burlap on balls.
- D. Set bare root stock on cushion of planting soil mixture. Spread roots, then carefully work backfill around roots by hand and puddle with water until backfill layers are completely saturated. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers above roots. Set collar 1" to 2" above adjacent finish landscape grades. Spread cut roots without tangling or turning up to surface. Cut injured roots clean, do not break.
- E. Set container grown stock as specified for balled and burlapped stock, except cut cans on two sides with an approved can cutter; remove bottoms of wooden boxes after partial backfilling so as not to damage root balls.
- F. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope: the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- G. Dish top of backfill to allow for mulching. For Spring planting, provide additional backfill berm around edge of excavations to form shallow saucer to collect water.

1. Note: Surface of all Shrub Beds shall be crowned or sloped as required to achieve a 3% minimum surface pitch and insure positive surface drainage.

- H. Wrap tree trunks of 2" caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures required before wrapping.

3.6 MECHANIZED TREE SPADE PLANTING – NOT USED

3.7 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches, do not prune for shape.
- B. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the Landscape Architect, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character and accomplish their use in the landscape design. Required shrub sizes are the size after pruning.
 1. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
 2. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

- A. Install trunk stabilization as follows unless otherwise indicated:
 1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension shown on Drawings. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Use two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
 3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.9 ROOT-BARRIER INSTALLATION – NOT USED

3.10 PLANTING IN PLANTERS - NOT USED

3.11 GROUND COVER AND PLANT PLANTING – NOT USED

3.12 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 1. Trees and tree like shrubs in Turf Areas: Apply mulch ring of 3inch thick with 36-inch radius around trunks or stems. Do not place mulch within six inches of trunk or stems
 2. Organic Mulch in Planting Areas: Apply three inches thickness of organic mulch or stone extending 12 inches beyond edge of individual planting pit or trench and over whole surface of plating area, and finish level with adjacent finished grades. Do not place mulch within three inches of trunks or stems.
 3. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch over whole surface area as shown on plans, and finish level with adjacent finish grades. Do not place mulch within 6-inches of trunks or stems.

3.13 EDGING INSTALLATION

- A. Shovel-cut Edging. Separate mulched areas from turf areas with a 45 degree 4 to 6-inch-deep, shovel cut edge.

3.14 TREE GRATE INSTALLATION – NOT USED

3.15 PLANT MAINTENANCE

- A. Begin maintenance immediately after planting. Maintain trees, shrubs and other plants until final acceptance, but in no case less than the following period: 60 days after planting.
- B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- C. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- E. Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one full year. Submit prior to the expiration of required maintenance period(s).

3.16 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.17 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. During landscape installation, store materials and equipment where directed.
- B. Protect landscape work and material from damage due to landscape operations, operations of other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.
- C. After installation and before final inspection, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.18 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

3.19 PREPARATION OF PLANTING SOIL

- A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps and other extraneous materials harmful or toxic to plant growth.
- B. Mix specified soil amendments at required rates (derived from Topsoil Analysis Report). Also include the following:
 - 1. For Trees and Shrubs (excluding coniferous ground cover): PHC Healthy Start 3-4-3 organic fertilizer/soil conditioner, shall be applied at 1/2 lb. per trunk diameter (cal.) inch for trees.

For shrubs as follows:

<u>Plant Size</u>	<u>Rate Cups</u>	<u>Lbs.</u>	<u># Plant Bag</u>
1 Gallon	1/2	1/4	100
5 Gallon	1	1/2	50
15 Gallon	2	1	25
24" Ball/Box	3	1 1/2	16
36" Ball/Box	5	2 1/2	10
42" Ball/Box	6	3	8
54" Ball/Box	8	4	6
72" Ball/Box	10	5	5

- C. Planting Soil Mixture: Shall consist of one-part off-site topsoil, as required, one part clean coarse builder's sand and one part humus. These shall be thoroughly mixed prior to any planting operations. The preceding shall be mixed with the soil amendments in Section 3.19 B.
- D. Lightweight Soil Mixture: (NOT USED)
- E. For pit and trench type planting, mix planting soil prior to back filling and/or placing stockpile at the site.
- F. For planting beds, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.

** END OF
PART 3 **

END OF
SECTION

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Grout.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.1 GROUT

- A. Description: ASTM C 1107, 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.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:
 - 1. Precast concrete manholes
 - 2. Precast concrete structures.
 - 3. Manufactured PVC structures.
 - 4. Storm drain pipe and appurtenances.
- B. This section includes all site stormwater drainage infrastructure up to and including the dissimilar materials adapter at building edge as shown in the contract drawings.
- C. Contractor to coordinate installation of building roof drainage downspout and cast iron boot installation with identified contractor for Bid Pack 2.

1.3 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Storm drain pipe.
- B. Shop Drawings: For the following:
 - 1. Manholes: Include plans, elevations, sections, details, and frames and covers.
 - 2. Catch Basins and Stormwater Inlets. Include plans, elevations, sections, details, and frames, covers, and grates.
 - 3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames and covers, design calculations, and concrete design-mix report.
- C. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.
- B. Handle manholes according to manufacturer's written rigging instructions.

- C. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.
- D. Handle downspout boots according to manufacturer's written instructions.

1.6 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 Construction Manager Owner no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Construction Manager's written permission.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that Storm Drainage System piping may be installed in compliance with original design and referenced standards.
 - 1. Locate existing Storm Drainage System piping and structures that are to be abandoned and closed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available 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 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 48 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 3. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

B. Corrugated PE Pipe and Fittings NPS 56 and NPS 60: AASHTO MP7, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

C. Pipe shall be manufactured by ADS, Inc. or approved equal.

2.4 REINFORCED CONCRETE PIPE:

1. Materials shall be in accordance with ASSHTO M-170.

2. Pipe class shall be Class III unless otherwise indicated on the drawings.

3. Joints to be tongue and groove.

4. Joining material may be either:

a. Portland cement mortar consisting of 1 part Portland cement, 2 parts sand and enough water to provide a workable mix, or

b. Bitumastic joint filler equal to Ram-Neck.

5. Joints shall be watertight under full flow conditions.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.

2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.6 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, precast reinforced concrete, of depth indicated with provision for rubber gasket joints.

1. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.

2. Riser Sections: 5-inch minimum thickness; 48-inch diameter, and lengths to provide depth indicated.

3. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone to match grade rings.

4. Grade Rings: Provide 2 or 3 reinforced concrete rings, with 12 maximum inches total thickness and match 24-inch diameter frame and cover.

5. Gaskets: ASTM C 443, rubber.

6. Steps: Cast into base, riser, and top sections sidewall at 12-to 16-inch intervals.

7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

8. Channel and Bench: Concrete or Brick.
 9. Coat Exterior Surface with two (2) coats of coal-tar epoxy, 15 mil. Minimum thickness.
- B. Manhole Steps: Wide enough for a man to place both feet on one step and designed to prevent lateral slippage off the step.
1. Material: Steel-reinforced plastic.
 2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy-duty, ductile iron, 24-inch inside diameter by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover, indented top design, with lettering "STORMDRAIN" cast into cover.

2.7 CATCH BASINS & INLETS

- A. Standard Precast Concrete Catch Basins & inlets: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Catch basins & inlets shall be according to the local utility standard as noted on the structure schedule.
 2. All materials for catch basins, steps, frames and grates, curb inlets and other appurtenances and incidentals shall conform to Sections 708 of the DelDOT specifications.
- B. PVC Plastic Catch Basins and inlets: Engineered, watertight, manufactured pvc bodies with ductile iron grates.
1. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.
 2. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or prior approved equal.
 3. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.
 4. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8", 10", 12", 15", 18", 24" and 30" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading for traffic areas or H-10 loading for pedestrian areas. 12" and 15" square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.
 5. Capable of H-20 and H-25 loadings, where specified.

2.8 STORMWATER DETENTION STRUCTURES

- A. Cast-in-Place Concrete, Stormwater Detention Structures: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
 - 1. Ballast: Increase thickness of concrete, as required to prevent flotation.
 - 2. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than 36 inches.
- B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service Include indented top design with lettering "STORM SEWER" cast into cover.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

- A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Flexible or rigid couplings for same or minor difference OD pipes.
 - b. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - c. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range and material as indicated on drawings:
 - 1. NPS 4 and NPS 36 Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
 - 2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, with groove and tongue ends.

3.3 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 design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing stormdrain system 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. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 - 2. Install piping below frost line.
 - 3. Install corrugated steel piping according to ASTM A 798/A 798M.
 - 4. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 6. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

3.4 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 3. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
 - 4. Join corrugated PE piping according to CPPA 100 and the following:
 - a. Use silttight couplings for Type 1, silttight joints.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Install outlets that spill onto grade, anchored with concrete, where indicated.
- C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- D. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318/318R.

3.9 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22.

3.10 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 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.11 IDENTIFICATION

1. Materials and their installation are specified in Division 31 Section "Earth Moving."

3.12 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. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- 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 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.

3.13 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

SECTION 334600 - SUBDRAINAGE

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 subdrainage systems for the following:
 - 1. Foundations.
 - 2. Underslab areas.
 - 3. Plaza decks.
 - 4. Retaining walls.
 - 5. Landscaped areas.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.
- E. PS: Polystyrene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Perforated-wall pipe and fittings.
 - 2. Solid-wall pipe and fittings.
 - 3. Drainage conduits.
 - 4. Drainage panels.
 - 5. Geotextile filter fabrics.
- B. Approval of waterproofing manufacturer's service agent for use of drainage panels against and for waterproofing membrane protection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.3 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
 - 1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 - 2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 - 3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.4 SOLID-WALL PIPES AND FITTINGS

- A. Cast-Iron Soil Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes, hub-and-spigot ends, gasketed joints.
 - 1. Gaskets: ASTM C 564, rubber, of thickness matching class of pipe.
- B. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.
 - 1. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.
- C. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.
 - 1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.
- D. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
 - 1. Gaskets: ASTM F 477, elastomeric seal.

2.5 SPECIAL PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
 - 1. Sleeve Materials:
 - a. For Concrete Pipes: ASTM C 443 , rubber.
 - b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - c. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - d. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 2. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.
 - 3. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.
- B. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.7 DRAINAGE CONDUITS

- A. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
 - 1. Available Manufacturers:
 - a. Varicore Technologies, Inc.
 - 2. Nominal Size: 6 inches high by approximately 1-1/4 inches thick.
 - a. Minimum In-Plane Flow: 15 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 - 3. Filter Fabric: Nonwoven, needle-punched geotextile.
 - 4. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
 - 5. Couplings: HDPE.
- B. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
 - 1. Available Manufacturers:

- a. Advanced Drainage Systems.
2. Nominal Size: 12 inches high by approximately 1 inch thick.
 - a. Minimum In-Plane Flow: 30 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
3. Nominal Size: 18 inches high by approximately 1 inch thick.
 - a. Minimum In-Plane Flow: 45 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
4. Filter Fabric: Nonwoven, PP geotextile.
5. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
6. Couplings: Corrugated HDPE band.

2.8 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches wide with drainage core faced with geotextile filter fabric.
 1. Available Manufacturers:
 - a. American Wick Drain Corporation.
 - b. Cosella-Dorken.
 - c. Eljen Corp.
 - d. Greenstreak, Inc.
 - e. JDR Enterprises, Inc.
 - f. LINQ Industrial Fabrics, Inc.
 - g. Midwest Diversified Technologies Incorporated.
 - h. TC Mirafi.
 2. Drainage Core: Three-dimensional, nonbiodegradable, molded PP or PS.
 - a. Minimum Compressive Strength: 10,000 lbf/sq. ft. when tested according to ASTM D 1621.
 - b. Minimum In-Plane Flow Rate: 2.8 gpm/ft. of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig when tested according to ASTM D 4716.
 3. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: Class 2.
 - b. Apparent Opening Size: No. 60 sieve, maximum.
 - c. Permittivity: 0.2 per second, minimum.
 4. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:

- a. Survivability: Class 2.
 - b. Apparent Opening Size: No. 60 sieve, maximum.
 - c. Permittivity: 0.02 per second, minimum.
5. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Available Manufacturers:
 - a. Colbond Geosynthetics.
 2. Drainage Core: Open-construction, resilient, approximately 0.4-inch- thick, plastic-filament mesh.
 - a. Minimum In-Plane Flow Rate: 2.4 gpm/ft. of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig when tested according to ASTM D 4716.
 3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. when tested according to ASTM D 4491.

2.9 SOIL MATERIALS

- A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

- A. Underground Subdrainage Piping:
1. Perforated PE pipe and fittings, couplings, and coupled joints.
 2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

- B. Underslab Subdrainage Piping:
 - 1. Perforated PE pipe and fittings, couplings, and coupled joints.
 - 2. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.
- C. Header Piping:
 - 1. PE drainage tubing and fittings, couplings, and coupled joints.
 - 2. PVC sewer pipe and fittings, couplings, and coupled joints.

3.4 CLEANOUT APPLICATIONS

- A. In Underground Subdrainage Piping:
 - 1. At Grade in Earth: Cast-iron cleanouts.
 - 2. At Grade in Paved Areas: Cast-iron cleanouts.
- B. In Underslab Subdrainage Piping:
 - 1. In Equipment Rooms and Unfinished Areas: Cast-iron cleanouts.

3.5 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Place impervious fill on subgrade adjacent to bottom of footing and compact to dimensions indicated, but not less than 6 inches deep and 12 inches wide after concrete footing forms have been removed.
- C. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- D. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- E. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- F. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- G. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- H. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- I. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- J. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

- K. Install vertical drainage panels as follows:
1. Coordinate placement with other drainage materials.
 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article. Do not install aggregate.
 3. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
 4. Wrap bottom of panel around drainage pipe.
 5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins, or double- double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 6. If additional panels are required on same row, cut away 4 inches of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
 7. If additional rows of panels are required, overlap lower panel with 4 inches of fabric.
 8. Cut panel as necessary to keep top 12 inches below finish grade.
 9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
- L. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- M. Place initial backfill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.6 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at inside edge of footings.
 - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
 - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.7 PLAZA DECK DRAINAGE INSTALLATION

- A. See Division 32 Section "Unit Paving."

3.8 RETAINING-WALL DRAINAGE INSTALLATION

- A. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.
- B. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- C. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- F. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- H. Install vertical drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 - 3. Mark horizontal chalk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
 - 4. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.

5. Wrap bottom of panel around drainage pipe.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away 4 inches of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
9. Cut panel as necessary to keep top 12 inches below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
11. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.

- I. Fill to Grade: Place satisfactory soil fill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.9 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.10 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 - 2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
 - 3. Plaza Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.
 - 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.
 - 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 - 6. Lay perforated pipe with perforations down.
 - 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install ABS piping according to ASTM D 2321.
- D. Install PE piping according to ASTM D 2321.
- E. Install PVC piping according to ASTM D 2321.
- F. Install clay piping according to ASTM C 12 and NCPI's "Clay Pipe Engineering Manual."
- G. Install concrete piping according to ACPA's "Concrete Pipe Handbook."

3.11 PIPE JOINT CONSTRUCTION

- A. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.
- B. Join ABS pipe and fittings according to ASTM D 2751.
- C. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."

- D. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
- E. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.
- F. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.
- G. Join perforated clay pipe and fittings with gaskets according to ASTM C 425.
- H. Join perforated concrete pipe and fittings with gaskets according to ASTM C 443.
- I. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.12 CLEANOUT INSTALLATION

- A. Cleanouts for Foundation Retaining-Wall Subdrainage:
 - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
 - 3. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.
- B. Cleanouts for Underslab Subdrainage:
 - 1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.13 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps.

3.14 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping.
 - 1. Install PE warning tape or detectable warning tape over ferrous piping.
 - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.15 FIELD QUALITY CONTROL

- A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.16 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600