

STATE OF DELAWARE
CAESAR RODNEY SCHOOL DISTRICT
CONTRACT # SRS2503

PROJECT MANUAL
FOR
HVAC RENOVATIONS
AT
MAGNOLIA MIDDLE SCHOOL

PREPARED
BY

GIPE ASSOCIATES, INC.
8719 BROOKS DRIVE
EASTON, MARYLAND, 21601

GIPE ASSOCIATES, INC. WORK ORDER #24008.B

BID DOCUMENTS
MARCH 5, 2025

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SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

SEAL

A. HVAC Engineer:

1. David R. Hoffman, P.E., LEED AP
2. Delaware Professional Engineer License #9773
3. President
4. Gipe Associates, Inc.
5. 8719 Brooks Drive
Easton, MD 21601
6. Tel: (410) 822-8688
Fax: (410) 822-6306
7. Email: dhoffman@gipe.net
8. Responsible for: Division 00, Division 01, Division 07, and Division 23



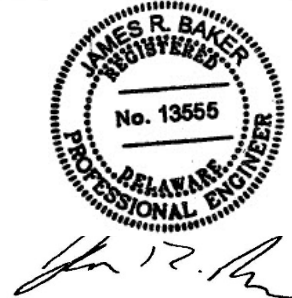
B. Electrical Engineer:

1. Dina Dixon, P.E., LEED AP
2. Delaware Professional Engineer License #17123
3. Vice President
4. Gipe Associates, Inc.
1220 East Joppa Road, Suite 223
Towson, MD 21286
5. Tel: (410) 832-2420
Fax: (410) 832-2418
6. Email: ddixon@gipe.net
7. Responsible for Division 26 and 28



C. Structural Engineer:

1. James R. Baker, P.E.
2. Delaware Professional Engineer License #13555
3. Managing Partner
4. Pilottown Engineering
5. 17585 Nassau Commons Boulevard, Unit 3
Lewes, DE 19958
6. Tel: (302) 703-1770 / Fax: Not Applicable
7. Email: jbaker@pilottownengineering.com
9. Responsible for Division 03, Division 04, and Division 05



D. Architect:

1. Carl Krienlen, AIA
2. Delaware Professional Architect License #7891
3. Principal
4. ABHA Architects
5. 1621 N. Lincoln St.
Wilmington, DE 19806
6. Tel: (302) 658-6426
Fax: (302) 658-8431
7. Email: ckrienlen@abha.com
8. Responsible for Division 02, Division 04, Division 05,
Division 06, Division 07 and Division 09



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INVITATION TO BID

Sealed bids for Contract No. SRS2503, will be received by Mr. James Pennewell at the Caesar Rodney School District's Facilities Management Office, at 7 Front Street, Wyoming, Delaware 19934 until 1:30 PM local time on Tuesday, April 29, 2025 and will be publicly opened and read aloud in the Conference Room at 2:00 PM. Bidder bears the risk of late delivery. Any bids received after the stated time will be returned unopened.

Project involves all labor, materials, tools, equipment, superintendence, transportation, and performing all work in strict accordance with the Specifications and Drawings for replacing the rooftop HVAC units, supporting electrical work, and supporting architectural/structural work. All work shall commence on the date of issuance of the Notice to Proceed and shall be completed and operational within four hundred seventy (470) calendar days thereafter.

Sealed bids shall be addressed to:
Mr. James Pennewell
Caesar Rodney School District
Facilities Management Office
7 Front Street
Wyoming, Delaware, 19934

A **NON-MANDATORY** Pre-Bid Meeting will be held on Thursday, March 27, 2025 at 3:30 PM at the Magnolia Middle School, 133 Thomas More Dr, Magnolia, Delaware 19962 for the purpose of establishing the listing of subcontractors and to answer questions. ATTENDANCE OF THIS MEETING IS **NOT** A PREREQUISITE FOR BIDDING ON THIS CONTRACT.

Contract documents may be obtained at the office of Gipe Associates, Inc. upon receipt of \$50.00 per electronic set/non-refundable and/or \$75.00 per hardcopy set/non-refundable. Checks are to be made payable to "Gipe Associates, Inc.". Purchase of the contract documents is a mandatory prerequisite for the prime bidder bidding on this contract.

Construction documents will be available for review at the following locations: Gipe Associates, Inc., 8719 Brooks Drive, Easton, Maryland and Caesar Rodney School District, Facilities Management Office, 7 Front Street, Wyoming, Delaware, 19934.

Bidders will not be subject to discrimination on the basis of race, creed, color, sex, sexual orientation, gender identity or national origin in consideration of this award, and Minority Business Enterprises, Disadvantaged Business Enterprises, Women-Owned Business Enterprises and Veteran-Owned Business Enterprises will be afforded full opportunity to submit bids on this contract. Each bid must be accompanied by a bid security equivalent to ten percent of the bid amount and all additive alternates. The successful bidder must post a performance bond and payment bond in a sum equal to 100 percent of the contract price upon execution of the contract. The Owner reserves the right to reject any or all bids and to waive any informalities therein. The Owner may extend the time and place for the opening of the bids from that described in the advertisement, with not less than two calendar days notice by certified delivery, facsimile machine or other electronic means to those bidders receiving plans.

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2. BIDDER'S REPRESENTATION
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4. BIDDING PROCEDURES
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ARTICLE 1: GENERAL

1.1 DEFINITIONS

1.1.1 Whenever the following terms are used, their intent and meaning shall be interpreted as follows:

1.2 STATE: The State of Delaware.

1.3 AGENCY: Contracting State Agency as noted on cover sheet.

1.4 DESIGNATED OFFICIAL: The agent authorized to act for the Agency.

1.5 BIDDING DOCUMENTS: Bidding Documents include the Bidding Requirements and the proposed Contract Documents. The Bidding Requirements consist of the Advertisement for Bid, Invitation to Bid, Instructions to Bidders, Supplementary Instructions to Bidders (if any), General Conditions, Supplementary General Conditions, General Requirements, Special Provisions (if any), the Bid Form (including the Non-collusion Statement), and other sample bidding and contract forms. The proposed Contract Documents consist of the form of Agreement between the Owner and Contractor, as well as the Drawings, Specifications (Project Manual) and all Addenda issued prior to execution of the Contract.

1.6 CONTRACT DOCUMENTS: The Contract Documents consist of the, Instructions to Bidders, Supplementary Instructions to Bidders (if any), General Conditions, Supplementary General Conditions, General Requirements, Special Provisions (if any), the form of agreement between the Owner and the Contractor, Drawings (if any), Specifications (Project Manual), and all addenda.

1.7 AGREEMENT: The form of the Agreement shall be AIA Document A101, Standard Form of Agreement between Owner and Contractor where the basis of payment is a STIPULATED SUM. In the case of conflict between the instructions contained therein and the General Requirements herein, these General Requirements shall prevail.

1.8 GENERAL REQUIREMENTS (or CONDITIONS): General Requirements (or conditions) are instructions pertaining to the Bidding Documents and to contracts in general. They contain, in summary, requirements of laws of the State; policies of the Agency and instructions to bidders.

1.9 SPECIAL PROVISIONS: Special Provisions are specific conditions or requirements peculiar to the bidding documents and to the contract under consideration and are supplemental to the General Requirements. Should the Special Provisions conflict with the General Requirements, the Special Provisions shall prevail.

1.10 ADDENDA: Written or graphic instruments issued by the Owner/Engineer prior to the execution of the contract which modify or interpret the Bidding Documents by additions, deletions, clarifications or corrections.

1.11 BIDDER OR VENDOR: A person or entity who formally submits a Bid for the material or Work contemplated, acting directly or through a duly authorized representative who meets the requirements set forth in the Bidding Documents.

- 1.12 SUB-BIDDER: A person or entity who submits a Bid to a Bidder for materials or labor, or both for a portion of the Work.
- 1.13 BID: A complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.
- 1.14 BASE BID: 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 (if any are required to be stated in the bid).
- 1.15 ALTERNATE BID (or ALTERNATE): An amount stated in the Bid, where applicable, 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.
- 1.16 UNIT PRICE: An amount stated in the Bid, where applicable, as a price per unit of measurement for materials, equipment or services or a portion of the Work as described in the Bidding Documents.
- 1.17 SURETY: The corporate body which is bound with and for the Contract, or which is liable, and which engages to be responsible for the Contractor's payments of all debts pertaining to and for his acceptable performance of the Work for which he has contracted.
- 1.18 BIDDER'S DEPOSIT: The security designated in the Bid to be furnished by the Bidder as a guaranty of good faith to enter into a contract with the Agency if the Work to be performed or the material or equipment to be furnished is awarded to him.
- 1.19 CONTRACT: The written agreement covering the furnishing and delivery of material or work to be performed.
- 1.20 CONTRACTOR: Any individual, firm or corporation with whom a contract is made by the Agency.
- 1.21 SUBCONTRACTOR: An individual, partnership or corporation which has a direct contract with a contractor to furnish labor and materials at the job site, or to perform construction labor and furnish material in connection with such labor at the job site.
- 1.22 CONTRACT BOND: The approved form of security furnished by the contractor and his surety as a guaranty of good faith on the part of the contractor to execute the work in accordance with the terms of the contract.
- 1.23 Whenever the word "Architect" shall appear on standard printed documents published by the American Institute of Architects (AIA), it shall mean "Engineer" and shall refer to Gipe Associates, Inc. or its appointed staff or sub-consultant.
- 1.24 Wherever the word "Owner" shall appear on standard printed document published by the American Institute of Architects (AIA), it shall mean the Caesar Rodney School District.

ARTICLE 2: BIDDER'S REPRESENTATIONS

2.1 PRE-BID MEETING

2.1.1 A pre-bid meeting for this project will be held at the time and place designated. Attendance at this meeting is a pre-requisite for submitting a Bid, unless this requirement is specifically waived elsewhere in the Bid Documents.

2.2 By submitting a Bid, the Bidder represents that:

2.2.1 The Bidder has read and understands the Bidding Documents and that the Bid is made in accordance therewith.

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

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

2.3 JOINT VENTURE REQUIREMENTS

2.3.1 For Public Works Contracts, each Joint Venturer shall be qualified and capable to complete the Work with their own forces.

2.3.2 Included with the Bid submission, and as a requirement to bid, a copy of the executed Joint Venture Agreement shall be submitted and signed by all Joint Venturers involved.

2.3.3 All required Bid Bonds, Performance Bonds, Material and Labor Payment Bonds must be executed by both Joint Venturers and be placed in both of their names.

2.3.4 All required insurance certificates shall name both Joint Venturers.

2.3.5 Both Joint Venturers shall sign the Bid Form and shall submit a copy of a valid Delaware Business License with their Bid.

2.3.6 Both Joint Venturers shall include their Federal E.I. Number with the Bid.

2.3.7 In the event of a mandatory Pre-bid Meeting, each Joint Venturer shall have a representative in attendance.

2.3.8 Due to exceptional circumstances and for good cause shown, one or more of these provisions may be waived at the discretion of the State.

2.4 ASSIGNMENT OF ANTITRUST CLAIMS

2.4.1 As consideration for the award and execution by the Owner of this contract, the Contractor hereby grants, conveys, sells, assigns and transfers to the State of Delaware all of its right, title and interests in and to all known or unknown causes of action it presently has or may now or hereafter acquire under the antitrust laws of the United States and the State of Delaware, relating to the particular goods or services purchased or acquired by the Owner pursuant to this contract.

ARTICLE 3: BIDDING DOCUMENTS

3.1 COPIES OF BID DOCUMENTS

- 3.1.1 Bidders may obtain complete sets of the Bidding Documents from the Architectural/Engineering firm designated in the Advertisement or Invitation to Bid in the number and for the deposit sum, if any, stated therein.
- 3.1.2 Bidders shall use complete sets of Bidding Documents for preparation of Bids. The issuing Agency nor the Engineer assumes no responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 3.1.3 Any errors, inconsistencies or omissions discovered shall be reported to the Engineer immediately.
- 3.1.4 The Agency and Engineer 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 report any errors, inconsistencies, or ambiguities discovered to the Engineer.
- 3.2.2 Bidders or Sub-bidders requiring clarification or interpretation of the Bidding Documents shall make a written request to the Engineer at least seven days prior to the date for receipt of Bids. Interpretations, corrections and changes to the Bidding Documents will be made by written Addendum. Interpretations, corrections, or changes to the Bidding Documents made in any other manner shall not be binding.
- 3.2.2a Direct inquiries and request for information (AIA G716) to: Gipe Associates, Inc. ATTN: David R. Hoffman, P.E., LEED AP, Email: dhoffman@gipe.net; Fax: 410-822-6306 no later than seven (7) days prior to bid due date.
- 3.2.3 The apparent silence of the specifications as to any detail, or the apparent omission from it of detailed description concerning any point, shall be regarded as meaning that only the best commercial practice is to prevail and only material and workmanship of the first quality are to be used. Proof of specification compliance will be the responsibility of the Bidder.
- 3.2.4 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for all permits, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of the Work.
- 3.2.5 The Owner will bear the costs for all impact and user fees associated with the project.

3.3 SUBSTITUTIONS

- 3.3.1 The materials, products and equipment described in the Bidding Documents establish a standard of quality, required function, dimension, and appearance to be met by any proposed substitution. The specification of a particular manufacturer or model number is not intended to be proprietary in any way. Substitutions of products for those named will be considered, providing that the Vendor certifies that the function, quality, and performance characteristics of the material offered is equal or superior to that specified. It shall be the Bidder's responsibility to assure that the proposed substitution will not affect the intent of the design, and to make any installation modifications required to accommodate the substitution.
- 3.3.2 Requests for substitutions shall be made in writing to the Engineer at least ten days prior to the date of the Bid Opening. Such requests shall include a complete description of the proposed substitution, drawings, performance and test data, explanation of required installation modifications due the substitution, and any other information necessary for an evaluation. The burden of proof of the merit of the proposed substitution is upon the proposer. The Engineer's decision of approval or disapproval shall be final. The Engineer is to notify Owner prior to any approvals.
- 3.3.3 If the Engineer approves a substitution prior to the receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding.
- 3.3.4 The Engineer shall have no obligation to consider any substitutions after the Contract award.
- 3.3.5 Refer to Section 016000 "Product Requirements" for additional requirements and procedures regarding substitutions.
- 3.4 ADDENDA
- 3.4.1 Addenda will be mailed or delivered to all who are known by the Engineer to have received a complete set of the 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 No Addenda will be issued later than 2 calendar days prior to the date for receipt of Bids except an Addendum withdrawing the request for Bids or one which extends the time or changes the location for the opening of bids.
- 3.4.4 Each bidder shall ascertain prior to submitting his Bid that they have received all Addenda issued, and shall acknowledge their receipt in their Bid in the appropriate space. Not acknowledging an issued Addenda could be grounds for determining a bid to be non-responsive.

ARTICLE 4: BIDDING PROCEDURES

- 4.1 PREPARATION OF BIDS
- 4.1.1 Submit the bids on the Bid Forms included with the Bidding Documents.
- 4.1.2 Submit the original Bid Form for each bid. Bid Forms may be removed from the project manual for this purpose.

- 4.1.3 Execute all blanks on the Bid Form in a non-erasable medium (typewriter or manually in ink).
- 4.1.4 Where so indicated by the makeup on the Bid Form, express sums in both words and figures, in case of discrepancy between the two, the written amount shall govern.
- 4.1.5 Interlineations, alterations or erasures must be initialed by the signer of the Bid.
- 4.1.6 BID ALL REQUESTED ALTERNATES AND UNIT PRICES, IF ANY. If there is no change in the Base Bid for an Alternate, enter "No Change". The Contractor is responsible for verifying that they have received all addenda issued during the bidding period. Work required by Addenda shall automatically become part of the Contract.
- 4.1.7 Make no additional stipulations on the Bid Form and do not qualify the Bid in any other manner.
- 4.1.8 Each copy of the Bid shall include the legal name of the Bidder and a statement whether the Bidder is a sole proprietor, a partnership, a corporation, or any legal entity, and 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 agent's authority to bind the Bidder.
- 4.1.9 Bidder shall complete the Non-Collusion Statement form included with the Bid Forms and include it with their Bid.
- 4.1.10 In the construction of all Public Works projects for the State of Delaware or any agency thereof, 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.
- 4.1.11 Each bidder shall include in their bid a copy of a valid Delaware Business License.
- 4.1.12 Each bidder shall include a signed Affidavit for the Bidder certifying compliance 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.
- 4.2 BID SECURITY
- 4.2.1 All bids shall be accompanied by a deposit of either a good and sufficient bond to the agency for the benefit of the agency, with corporate surety authorized to do business in this State, the form of the bond and the surety to be approved by the agency, or a security of the bidder assigned to the agency, for a sum equal to at least 10% of the bid plus all add alternates, or in lieu of the bid bond a security deposit in the form of a certified check, bank treasurer's check, cashier's check, money order, or other prior approved secured deposit assigned to the State. The bid bond need not be for a specific sum, but may be stated to be for a sum equal to 10% of the bid plus all add alternates to which it relates and not to exceed a certain stated

sum, if said sum is equal to at least 10% of the bid. The Bid Bond form used shall be the standard OMB form (attached).

4.2.2 The Agency has the right to retain the bid security of Bidders to whom an award is being considered until either a formal contract has been executed and bonds have been furnished or the specified time has elapsed so the Bids may be withdrawn or all Bids have been rejected.

4.2.3 In the event of any successful Bidder refusing or neglecting to execute a formal contract and bond within 20 days of the awarding of the contract, the bid bond or security deposited by the successful bidder shall be forfeited.

4.3 SUBCONTRACTOR LIST

4.3.1 In accordance with Title 29, Chapter 69, Section 6962(d)(10)b of the Delaware Code, each Bidder shall submit with their Bid a completed List of Sub-Contractors included with the Bid Form. NAME ONLY ONE SUBCONTRACTOR FOR EACH TRADE. The bidder must list **in each category** the full name and address (City & State) of the subcontractor that the Bidder will be using to perform the work and provide material for that subcontractor category. Should the Bidder's listed subcontractor intend to provide any of their subcontractor category of work through a third-tier contractor, the Bidder shall list that third-tier contractor's full name and address (City & State). **If the Bidder intends to perform any category of work itself, it must list its full name and address.** For clarification, if the Bidder intends to perform the work themselves, the Bidder **may not** insert "not applicable", "N/A", "self" or anything other than its own full name and address (City & State). To do so shall cause the bid to be rejected. In addition, the failure to produce a completed subcontractor list with the bid submittal shall cause the bid to be rejected. If you have more than three (3) third-tier contractors to report in any subcontractor category, print out additional page(s) containing the appropriate category, complete the rest of your list of third-tier contractors for that category, notate the addition in parentheses as (CONTINUATION) next to the subcontractor category and an asterisk (*) next to any additional third-tier contractors, and submit it with your bid.

4.3.2 It is the responsibility of the Contractor to ensure that their Subcontractors are in compliance with the provisions of this law. Also, if a Contractor elects to list themselves as a Subcontractor for any category, they must specifically name themselves on the Bid Form and be able to document their capability to act as Subcontractor in that category in accordance with this law.

4.4 AFFIDAVIT OF CONTRACTOR QUALIFICATIONS

4.4.1 In accordance with Title 29, Chapter 69, Section 6962(d)(10)b.3 of the Delaware Code, each Bidder shall submit with their Bid the Affidavit of Contractor Qualifications certifying that the Bidder will abide by the contractor's qualifications outlined in the construction bid specifications for the duration of the contract term. After a contract has been awarded the successful bidder shall not substitute another subcontractor whose name was submitted on the Subcontractor Form except for the reasons in the statute and not without written consent from the awarding agency. Failure to utilize the subcontractors on the list will subject the successful bidder to penalties as outlined in the General Requirements Section 5.2 of the contract.

4.5 AFFIDAVIT OF CRAFT TRAINING COMPLIANCE

4.5.1 In accordance with Title 29, Chapter 69, Section 6962(d)(13) of the Delaware Code, contractors and subcontractors must provide craft training for journeyman and apprentice levels if all of the following apply:

- A. A project meets the prevailing wage requirement under Title 29, Chapter 69, Section 6960 of the Delaware Code.
- B. The contractor employs 10 or more total employees.
- C. The project is not a federal highway project

Failure to provide required craft training on the project may subject the successful contractor and/or subcontractor(s) to penalties as outlined in Title 29, Chapter 69, Section 6962(d)(13) of the Delaware Code.

Bidders shall submit the Affidavit of Craft Training Compliance prior to contract execution.

4.6 EQUALITY OF EMPLOYMENT OPPORTUNITY ON PUBLIC WORKS

4.6.1 During the performance of this contract, the contractor agrees as follows:

- A. 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 affirmative action to ensure the 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.
- B. 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."

4.7 PREVAILING WAGE REQUIREMENT

4.7.1 Wage Provisions: For renovation and new construction projects whose costs exceed the thresholds contained in Delaware Code, Title 29, Section 6960, the minimum wage rates for various classes of laborers and mechanics shall be as determined by the Department of Labor, Division of Industrial Affairs of the State of Delaware.

4.7.2 The employer shall pay all mechanics and labors employed directly upon the site of 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 those stated in the specifications, regardless of any contractual relationship which may be alleged to exist between the employer and such laborers and mechanics.

4.7.3 The scale of the wages to be paid shall be posted by the employer in a prominent and easily accessible place at the site of the work.

4.7.4 Every contract based upon these specifications shall contain a stipulation that sworn payroll information, as required by the Department of Labor, be furnished weekly. The Department of Labor shall keep and maintain the sworn payroll information for a period of 6 months from the last day of the work week covered by the payroll.

4.8 SUBMISSION OF BIDS

4.8.1 Enclose the Bid, the Bid Security, and any other documents required to be submitted with the Bid in a sealed opaque envelope. Address the envelope to the party receiving the Bids. Identify with the project name, project number, and the Bidder's name and address. If the Bid is sent by mail, enclose the sealed envelope in a separate mailing envelope with the notation "BID ENCLOSED" on the face thereof. The State is not responsible for the opening of bids prior to bid opening date and time that are not properly marked.

4.8.2 Deposit Bids at the designated location prior to the time and date for receipt of bids indicated in the Advertisement for Bids. Bids received after the time and date for receipt of bids will be marked "LATE BID" and returned.

4.8.3 Bidder assumes full responsibility for timely delivery at location designated for receipt of bids.

4.8.4 Oral, telephonic or telegraphic bids are invalid and will not receive consideration.

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

4.9 MODIFICATION OR WITHDRAW OF BIDS

4.9.1 Prior to the closing date for receipt of Bids, a Bidder may withdraw a Bid by personal request and by showing proper identification to the Engineer. A request for withdraw by letter or fax, if the Engineer is notified in writing prior to receipt of fax, is acceptable. A fax directing a modification in the bid price will render the Bid informal, causing it to be ineligible for consideration of award. Telephone directives for modification of the bid price shall not be permitted and will have no bearing on the submitted proposal in any manner.

4.9.2 Bidders submitting Bids that are late shall be notified as soon as practicable and the bid shall be returned.

4.9.3 A Bid may not be modified, withdrawn or canceled by the Bidder during a thirty (30) day period following the time and date designated for the receipt and opening of Bids, and Bidder so agrees in submitting their Bid. Bids shall be binding for 30 days after the date of the Bid opening.

ARTICLE 5: CONSIDERATION OF BIDS

5.1 OPENING/REJECTION OF BIDS

- 5.1.1 Unless otherwise stated, Bids received on time will be publicly opened and will be read aloud. An abstract of the Bids will be made available to Bidders.
- 5.1.2 The Agency shall have the right to reject any and 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.
- 5.1.3 If the Bids are rejected, it will be done within thirty (30) calendar day of the Bid opening.

5.2 COMPARISON OF BIDS

- 5.2.1 After the Bids have been opened and read, the bid prices will be compared and the result of such comparisons will be made available to the public. Comparisons of the Bids may be based on the Base Bid plus desired Alternates. The Agency shall have the right to accept Alternates in any order or combination.
- 5.2.2 The Agency reserves the right to waive technicalities, to reject any or all Bids, or any portion thereof, to advertise for new Bids, to proceed to do the Work otherwise, or to abandon the Work, if in the judgment of the Agency or its agent(s), it is in the best interest of the State.
- 5.2.3 An increase or decrease in the quantity for any item is not sufficient grounds for an increase or decrease in the Unit Price.
- 5.2.4 The prices quoted are to be those for which the material will be furnished F.O.B. Job Site and include all charges that may be imposed during the period of the Contract.
- 5.2.5 No qualifying letter or statements in or attached to the Bid, or separate discounts will be considered in determining the low Bid except as may be otherwise herein noted. Cash or separate discounts should be computed and incorporated into Unit Bid Price(s).

5.3 DISQUALIFICATION OF BIDDERS

- 5.3.1 An agency shall determine that each Bidder on any Public Works Contract is responsible before awarding the Contract. Factors to be considered in determining the responsibility of a Bidder include:
 - A. The Bidder's financial, physical, personnel or other resources including Subcontracts;
 - B. The Bidder's record of performance on past public or private construction projects, including, but not limited to, defaults and/or final adjudication or admission of violations of the Prevailing Wage Laws in Delaware or any other state;
 - C. The Bidder's written safety plan;

- D. Whether the Bidder is qualified legally to contract with the State;
 - E. Whether the Bidder supplied all necessary information concerning its responsibility; and,
 - F. Any other specific criteria for a particular procurement, which an agency may establish; provided however, that, the criteria be set forth in the Invitation to Bid and is otherwise in conformity with State and/or Federal law.
- 5.3.2 If an agency determines that a Bidder is nonresponsive and/or nonresponsible, the determination shall be in writing and set forth the basis for the determination. A copy of the determination shall be sent to the affected Bidder within five (5) working days of said determination.
- 5.3.3 In addition, any one or more of the following causes may be considered as sufficient for the disqualification of a Bidder and the rejection of their Bid or Bids.
- 5.3.3.1 More than one Bid for the same Contract from an individual, firm or corporation under the same or different names.
 - 5.3.3.2 Evidence of collusion among Bidders.
 - 5.3.3.3 Unsatisfactory performance record as evidenced by past experience.
 - 5.3.3.4 If the Unit Prices are obviously unbalanced either in excess or below reasonable cost analysis values.
 - 5.3.3.5 If there are any unauthorized additions, interlineation, conditional or alternate bids or irregularities of any kind which may tend to make the Bid incomplete, indefinite or ambiguous as to its meaning.
 - 5.3.3.6 If the Bid is not accompanied by the required Bid Security and other data required by the Bidding Documents.
 - 5.3.3.7 If any exceptions or qualifications of the Bid are noted on the Bid Form.
- 5.4 ACCEPTANCE OF BID AND AWARD OF CONTRACT
- 5.4.1 A formal Contract shall be executed with the successful Bidder within twenty (20) calendar days after the award of the Contract.
 - 5.4.2 Per Section 6962(d)(13) a., Title 29, Delaware Code, "The contracting agency shall award any public works contract within thirty (30) days of the bid opening to the lowest responsive and responsible Bidder, unless the Agency elects to award on the basis of best value, in which case the election to award on the basis of best value shall be stated in the Invitation To Bid."
 - 5.4.3 Each Bid on any Public Works Contract must be deemed responsive by the Agency to be considered for award. A responsive Bid shall conform in all material respects to the requirements and criteria set forth in the Contract Documents and specifications.

- 5.4.4 The Agency shall have the right to accept Alternates in any order or combination, and to determine the low Bidder on the basis of the sum of the Base Bid, plus accepted Alternates.
- 5.4.5 The successful Bidder shall execute a formal contract, submit the required Insurance Certificate, and furnish good and sufficient bonds, unless specifically waived in the General Requirements, in accordance with the General Requirement, within twenty (20) days of official notice of contract award. The successful Bidder shall provide, at least two business days prior to contract execution, copies of the Employee Drug Testing Program for the Bidder and all listed Subcontractors. Bonds shall be for the benefit of the Agency with surety in the amount of 100% of the total contract award. Said Bonds shall be conditioned upon the faithful performance of the contract. Bonds shall remain in affect for period of one year after the date of substantial completion.
- 5.4.6 If the successful Bidder fails to execute the required Contract, Bond and all required information, as aforesaid, within twenty (20) calendar days after the date of official Notice of the Award of the Contract, their Bid guaranty shall immediately be taken and become the property of the State for the benefit of the Agency as liquidated damages, and not as a forfeiture or as a penalty. Award will then be made to the next lowest qualified Bidder of the Work or readvertised, as the Agency may decide.
- 5.4.7 Each bidder shall supply with its bid its taxpayer identification number (i.e., federal employer identification number or social security number) and a copy of its Delaware business license, and should the vendor be awarded a contract, such vendor 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.
- 5.4.8 The Bid Security shall be returned to the successful Bidder upon the execution of the formal contract. The Bid Securities of unsuccessful bidders shall be returned within thirty (30) calendar days after the opening of the Bids.

ARTICLE 6: POST-BID INFORMATION

- 6.1 **CONTRACTOR'S QUALIFICATION STATEMENT**
- 6.1.1 Bidders to whom an award of a Contract is under consideration shall, if requested by the Agency, submit a properly executed AIA Document A305, Contractor's Qualification Statement, unless such a statement has been previously required and submitted.
- 6.2 **BUSINESS DESIGNATION FORM**
- 6.2.1 Successful bidder shall be required to accurately complete an Office of Management and Budget Business Designation Form for Subcontractors.

- 6.3 Bidders to whom an award of a Contract has been made must produce their Delaware Business License before the Contract can be executed.

ARTICLE 7: PERFORMANCE BOND AND PAYMENT BOND

7.1 BOND REQUIREMENTS

- 7.1.1 The cost of furnishing the required Bonds, that are stipulated in the Bidding Documents, shall be included in the Bid.
- 7.1.2 If the Bidder is required by the Agency to secure a bond from other than the Bidder's usual sources, changes in cost will be adjusted as provide in the Contract Documents.
- 7.1.3 The Performance and Payment Bond forms used shall be the standard OMB forms (attached).

7.2 TIME OF DELIVERY AND FORM OF BONDS

- 7.2.1 The bonds shall be dated on or after the date of the Contract.
- 7.2.2 The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix a certified and current copy of the power of attorney.

ARTICLE 8: FORM OF AGREEMENT BETWEEN AGENCY AND CONTRACTOR

- 8.1 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.

ARTICLE 9: ADDITIONAL INSTRUCTIONS TO BIDDERS

9.1 TIME OF COMPLETION

- 9.1.1 The Owner desires substantial completion of total project to be no later than four hundred forty (440) calendar days from Notice to Proceed and final completion thirty (30) calendar days thereafter. This provision is of the essence.

END OF INSTRUCTIONS TO BIDDERS

BID FORM

To: Caesar Rodney School District
Facilities Management Office
7 Front Street
Wyoming, Delaware, 19934

Phone No.: () _____ - _____ **Fax No.:** () _____ - _____

\$ _____
(\$ _____)

Add/Deduct: _____
(\$ _____)

Add/Deduct: _____

Add/Deduct: _____
 Chiller #1 (\$) _____ Chiller #2 (\$) _____

The amount of stated allowances (\$50,000.00) shall be included in the Bidder's Base Bid.

CAESAR RODNEY SCHOOL DISTRICT - MAGNOLIA MIDDLE SCHOOL - HVAC RENOVATIONS
MAGNOLIA, DELAWARE

BID FORM

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for thirty (30) days from the date of opening of bids (60 days for School Districts and Department of Education), and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid.

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

Should I/We be awarded this contract, I/We pledge to achieve substantial completion of all the work within _____ calendar days of the Notice to Proceed. The base bid rooftop units lead time is _____ calendar days from an approved submittal. The alternate rooftop units lead time is _____ calendar days from an approved submittal.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

(State of Corporation)

Business Address: _____

Witness: _____ By: _____
(SEAL) (Authorized Signature)

(Title)
Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Affidavit of Employee Drug Testing Program
Affidavit of Contractor Qualifications
Bid Security
(Others as Required by Project Manuals)

CAESAR RODNEY SCHOOL DISTRICT - MAGNOLIA MIDDLE SCHOOL - HVAC RENOVATIONS
MAGNOLIA, DELAWARE

BID FORM

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 69, Section 6962(d)(10)b of the Delaware Code, the following subcontractor listing must accompany any bid submittal. The bidder must list **in each category** the full name and address (City & State) of the sub-contractor that the bidder will be using to perform the work and provide material for that subcontractor category. Should the bidder’s listed subcontractor intend to provide any of their subcontractor category of work through a third-tier contractor, the bidder shall list that third-tier contractor’s full name and address (City & State). **If the bidder intends to perform any category of work itself, it must list its full name and address.** For clarification, if the bidder intends to perform the work themselves, the bidder **may not** insert “not applicable”, “N/A”, “self” or anything other than its own full name and address (City & State). To do so shall cause the bid to be rejected. In addition, the failure to produce a completed subcontractor list with the bid submittal shall cause the bid to be rejected. If you have more than three (3) third-tier contractors to report in any subcontractor category, print out additional page(s) containing the appropriate category, complete the rest of your list of third-tier contractors for that category, notate the addition in parentheses as (CONTINUATION) next to the subcontractor category and an asterisk (*) next to any additional third-tier contractors, and submit it with your bid.

<u>Subcontractor Category</u>	<u>Subcontractor</u>	<u>Address (City & State)</u>	<u>Subcontractors tax-payer ID # or Delaware Business license #</u>
1. HVAC Sheet Metal			
2. Electrical			
3. Insulation			
4. HVAC Piping			
5. Testing and Balancing			
6. Structural Steel			
7. Roofing Contractor			
8. ATC Controls			

CAESAR RODNEY SCHOOL DISTRICT - MAGNOLIA MIDDLE SCHOOL - HVAC RENOVATIONS
MAGNOLIA, DELAWARE

BID FORM

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date (*to the Office of Management and Budget, Division of Facilities Management*).

All the terms and conditions of (*Project or Contract Number*) have been thoroughly examined and are understood.

NAME OF BIDDER:

**AUTHORIZED REPRESENTATIVE
(TYPED):**

**AUTHORIZED REPRESENTATIVE
(SIGNATURE):**

TITLE:

ADDRESS OF BIDDER:

E-MAIL:

PHONE NUMBER:

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

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

**AFFIDAVIT
OF
EMPLOYEE DRUG TESTING PROGRAM**

4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds.

We hereby certify that we have in place or will implement during the entire term of the contract a Mandatory Drug Testing Program for our employees on the jobsite, including subcontractors, that complies with this regulation:

Contractor/Subcontractor Name: _____

Contractor/Subcontractor Address: _____

Authorized Representative (typed or printed): _____

Authorized Representative (signature): _____

Title: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

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

CAESAR RODNEY SCHOOL DISTRICT - MAGNOLIA MIDDLE SCHOOL - HVAC RENOVATIONS
MAGNOLIA, DELAWARE

**AFFIDAVIT
OF
CONTRACTOR QUALIFICATIONS**

We hereby certify that we will abide by the contractor's qualifications outlined in the construction bid specifications for the duration of the contract term.

In accordance with Title 29, Chapter 69, Section 6962(d)(10)b.3 of the Delaware Code, after a contract has been awarded the successful bidder shall not substitute another subcontractor whose name was submitted on the Subcontractor Form except for the reasons in the statute and not without written consent from the awarding agency. Failure to utilize the subcontractors on the list will subject the successful bidder to penalties as outlined in the General Requirements Section 5.2 of the contract.

Contractor Name: _____

Contractor Address: _____

Authorized Representative (typed or printed): _____

Authorized Representative (signature): _____

Title: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

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

BID BOND

Bid Bond attached shall be utilized on this project.

THIS PAGE LEFT INTENTIONALLY BLANK

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 Caesar Rodney School District (Magnolia Middle School Rooftop Units AHU #2 and AHU #4
Replacements) 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 Caesar Rodney School District (Magnolia Middle School HVAC Renovations) 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 Caesar Rodney School
District (Magnolia Middle School HVAC Renovations) 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: _____

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STANDARD FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR A101-2017

The contract to be utilized on this project shall be the “Standard Form of Agreement Between Owner and Contractor” AIA Document A101-2017.

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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. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

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.

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:

Init.

(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.)

Init.

☐ 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)

CONTRACTOR (Signature)

(Printed name and title)

(Printed name and title)

Additions and Deletions Report for **AIA® Document A101™ – 2017**

This Additions and Deletions Report, as defined on page 1 of the associated document, reproduces below all text the author has added to the standard form AIA document in order to complete it, as well as any text the author may have added to or deleted from the original AIA text. Added text is shown underlined. Deleted text is indicated with a horizontal line through the original AIA text.

Note: This Additions and Deletions Report is provided for information purposes only and is not incorporated into or constitute any part of the associated AIA document. This Additions and Deletions Report and its associated document were generated simultaneously by AIA software at 15:35:54 ET on 05/31/2019.

Certification of Document's Authenticity

AIA® Document D401™ – 2003

I, , hereby certify, to the best of my knowledge, information and belief, that I created the attached final document simultaneously with its associated Additions and Deletions Report and this certification at 15:35:54 ET on 05/31/2019 under Order No. 1840604654 from AIA Contract Documents software and that in preparing the attached final document I made no changes to the original text of AIA® Document A101™ - 2017, Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum, as published by the AIA in its software, other than those additions and deletions shown in the associated Additions and Deletions Report.

(Signed)

(Title)

(Dated)

SECTION 00 54 13
SUPPLEMENT TO AGREEMENT BETWEEN OWNER AND CONTRACTOR A101-2017

The following supplements modify the “Standard Form of Agreement Between Owner and Contractor,” AIA Document A101-2017. Where a portion of the Standard Form of Agreement is modified or deleted by the following, the unaltered portions of the Standard Form of Agreement shall remain in effect.

ARTICLE 3: DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

3.1 Delete paragraph 3.1 in its entirety and replace with the following:

“The date of Commencement of the Work shall be a date set forth in a notice to proceed issued by the Owner.”

ARTICLE 5: PAYMENTS

5.1 PROGRESS PAYMENTS

5.1.3 Delete paragraph 5.1.3 in its entirety and replace with the following:

“Provided that a valid Application for Payment is received by the Architect that meets all requirements of the Contract, payment shall be made by the Owner not later than 30 days after the Owner receives the valid Application for Payment.”

5.3 Insert the interest rate of “1% per month not to exceed 12% per annum.”

ARTICLE 6: DISPUTE RESOLUTION

6.2 BINDING DISPUTE RESOLUTION

Check Other – and add the following sentence:

"Any remedies available in law or in equity."

ARTICLE 7: TERMINATION or SUSPENSION

7.1.1 Delete paragraph 7.1.1 in its entirety.

ARTICLE 8: MISCELLANEOUS PROVISIONS

8.4 Delete paragraph 8.4 in its entirety and replace with the following:

“The Contractor’s representative shall not be changed without ten days written notice to the Owner.”

HVAC RENOVATIONS
SRS2503

CAESAR RODNEY SCHOOL DISTRICT
MAGNOLIA MIDDLE SCHOOL

END OF SUPPLEMENT TO AGREEMENT BETWEEN OWNER AND CONTRACTOR

PERFORMANCE BOND

Performance Bond attached shall be utilized on this project.

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PERFORMANCE BOND

STATE OF DELAWARE OFFICE OF MANAGEMENT AND BUDGET

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 Caesar Rodney School District (Magnolia Middle School Cafeteria HVAC Renovations) (“**Owner**”), 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 Magnolia Middle School HVAC Renovations 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:

PAYMENT BOND

Payment Bond attached shall be utilized on this project.

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PAYMENT BOND

STATE OF DELAWARE OFFICE OF MANAGEMENT AND BUDGET

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 Caesar Rodney School District (Magnolia Middle School HVAC Renovations) ("**Owner**"), 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 Magnolia Middle School HVAC Renovations 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:

SUBMITTAL TRANSMITTAL FORM – CSI FORM 12.1A

Submittal Transmittal Form attached shall be utilized on this project.

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SUBMITTAL TRANSMITTAL

Project: _____ Date: _____
A/E Project Number: _____

TRANSMITTAL To (Contractor): _____ Date: _____ Submittal No. _____
A From (Subcontractor): _____ By: _____ ☐ Resubmission

Qty.	Reference / Number	Title / Description / Manufacturer	Spec. Section Title and Paragraph / Drawing Detail Reference

☐ Submitted for review and approval	☐ Substitution involved - Substitution request attached
☐ Resubmitted for review and approval	☐ If substitution involved, submission includes point-by-point comparative data or preliminary details
☐ Complies with contract requirements	☐ Items included in submission will be ordered immediately upon receipt of approval
☐ Will be available to meet construction schedule	
☐ A/E review time included in construction schedule	

Other remarks on above submission: _____ ☐ One copy retained by sender

TRANSMITTAL To (A/E): _____ Attn: _____ Date Rec'd by Contractor: _____
B From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

☐ Approved	☐ Revise / Resubmit
☐ Approved as noted	☐ Rejected / Resubmit

Other remarks on above submission: _____ ☐ One copy retained by sender

TRANSMITTAL To (Contractor): _____ Attn: _____ Date Rec'd by A/E: _____
C From (A/E): _____ ☐ Other By: _____ Date Trnsmt'd by A/E: _____

☐ Approved	☐ Provide file copy with corrections identified
☐ Approved as noted	☐ Sepia copies only returned
☐ Not subject to review	☐ Point-by-point comparative data required to complete approval process
☐ No action required	☐ Submission Incomplete / Resubmit
☐ Revise / Resubmit	
☐ Rejected / Resubmit	
☐ Approved as noted / Resubmit	

Other remarks on above submission: _____ ☐ One copy retained by sender

TRANSMITTAL To (Subcontractor): _____ Attn: _____ Date Rec'd by Contractor: _____
D From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ One copy retained by sender

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SCHEDULE OF VALUES FORM – AIA DOCUMENT G703-1992

Schedules of Values Form attached shall be utilized on this project.

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AIA Document G703™ – 1992

Continuation Sheet

AIA Document, G702TM-1992, Application and Certification for Payment, or G736TM-2009, Project Application and Project Certificate for Payment, Construction Manager as Adviser Edition, containing Contractor's signed certification is attached.

In tabulations below, amounts are in US dollars.

Use Column I on Contracts where variable retainage for line items may apply.

APPLICATION NO:

APPLICATION DATE:

PERIOD TO:

ARCHITECT'S PROJECT NO.:

001

[illegible]

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APPLICATION AND CERTIFICATE FOR PAYMENT FORM – AIA DOCUMENT G702-1992

Application and Certificate for Payment Form attached herein shall be utilized on this project.

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Application and Certificate for Payment

TO OWNER:		PROJECT:		APPLICATION NO: 001	Distribution to:
				PERIOD TO:	OWNER: ☐
				CONTRACT FOR: General Construction	ARCHITECT: ☐
				CONTRACT DATE:	CONTRACTOR: ☐
				PROJECT NOS: / /	FIELD: ☐
					OTHER: ☐

CONTRACTOR'S APPLICATION FOR PAYMENT

Application is made for payment, as shown below, in connection with the Contract. Continuation Sheet, AIA Document G703, is attached.

1. ORIGINAL CONTRACT SUM \$0.00
2. NET CHANGE BY CHANGE ORDERS \$0.00
3. CONTRACT SUM TO DATE (Line 1 + 2) \$0.00
4. TOTAL COMPLETED & STORED TO DATE (Column G on G703) \$0.00
5. RETAINAGE:
 - a. 0 % of Completed Work (Column D + E on G703) \$0.00
 - b. 0 % of Stored Material (Column F on G703) \$0.00

Total Retainage (Lines 5a + 5b or Total in Column I of G703) \$0.00

6. TOTAL EARNED LESS RETAINAGE \$0.00
(Line 4 Less Line 5 Total)
7. LESS PREVIOUS CERTIFICATES FOR PAYMENT \$0.00
(Line 6 from prior Certificate)

8. CURRENT PAYMENT DUE \$0.00
9. BALANCE TO FINISH, INCLUDING RETAINAGE
(Line 3 less Line 6) \$0.00

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	\$0.00	\$0.00
Total approved this Month	\$0.00	\$0.00
TOTALS	\$0.00	\$0.00
NET CHANGES by Change Order		\$0.00

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner, and that current payment shown herein is now due.

CONTRACTOR: _____ **Date:** _____

By: _____

State of: _____

County of: _____

Subscribed and sworn to before me this _____ day of _____

Notary Public: _____

My Commission expires: _____

ARCHITECT'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

AMOUNT CERTIFIED \$0.00
(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)

ARCHITECT: _____ **Date:** _____

By: _____

This Certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the Contractor named herein. Issuance, payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

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CAD FILE RELEASE FORM

CAD File Release Form attached shall be utilized on this project.

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Gipe Associates, Inc.
CONSULTING ENGINEERS

RELEASE OF ELECTRONIC MEDIA (DRAWINGS, SPECIFICATIONS, ETC.)

PROJECT: _____ DATE: _____

PROJECT NO: _____ RECORD DOCUMENT DATE _____

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by Gipe Associates, Inc., the Owner, its agents, other design professionals, or contractors covenants and agrees that all such drawings and data are instruments of service of Gipe Associates, Inc., and its Consultants (hereinafter referred to as the Engineer), who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

For documentation purposes, the original electronic media (disks) will be retained by the Engineer, and both parties acknowledge that the referenced, dated Record Document is the actual contract deliverable. The Owner shall be permitted to retain copies of Drawings and Specifications prepared in electronic form for the Owner's convenience in connection with the specific project for which this information was prepared. Due to the potential that the information set forth on the electronic media can be modified, unintentionally or otherwise, the Engineer reserves the right to remove all indicia of its ownership and/or involvement from each document on the electronic media.

No warranty is made or implied as to the suitability of these files or the information they contain for such purpose. In all cases, the Contract Drawings and Specifications shall define all requirements. The Contractor is responsible for verification of Drawings and field conditions and/or recognizing the impermanence and changeability of electronic files, assumes all responsibility for their use and alteration.

The Owner, its Agents or other design professionals further agree not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Owner, its Agents, other design professionals, or contractors agree to waive all claims against the Engineer, and to the fullest extent permitted by law, to indemnify and hold the Engineer harmless from any damage, liability or cost, including reasonable attorneys' fees and cost of defense, arising from any changes or use of the Drawings and data made by anyone other than the Engineer without the prior written consent of the Engineer. Any such unauthorized use or reuse will be at the Owner's sole risk and without liability or legal exposure to the Engineer.

Under no circumstances shall transfer of the Drawings and other instruments of service on electronic media for use by the Owner, its Agents or other design professionals be deemed a sale by the Engineer, and the Engineer makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

Accepted - Owner or Owner's Representative

Printed Name and Title

Date

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REQUEST FOR INTERPRETATION FORM – CSI FORM 13.2A

Request for Interpretation Form attached shall be utilized on this project.

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Advancement
of Construction
Technology

REQUEST FOR INTERPRETATION

Project: _____

R.F.I. Number: _____

From: _____

To: _____

Date: _____

A/E Project Number: _____

Re: _____

Contract For: _____

Specification Section:

Paragraph:

Drawing Reference:

Detail:

Request:

Signed by:

Date:

Response:

☐ Attachments

Response From:

To:

Date Rec'd:

Date Ret'd:

Signed by:

Date:

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

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REQUEST FOR INTERPRETATION LOG – CSI LOG FORM 13.2B

Request for Interpretation Log attached shall be utilized on this project.

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Owner: _____ Contractor: _____

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SUBSTITUTION REQUEST FORM (DURING CONSTRUCTION) – CSI FORM 13.1A

Substitution Request Form CSI Form 13.1A attached shall be utilized on this project.

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SUBSTITUTION REQUEST (After the Bidding Phase)

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

A/E Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
Manufacturer: _____ Address: _____ Phone: _____
Trade Name: _____ Model No.: _____
Installer: _____ Address: _____ Phone: _____
History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached - REQUIRED BY A/E

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____
Address: _____ Owner: _____
_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitution: _____ (\$ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SUBSTITUTION REQUEST (Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

A/E's REVIEW AND ACTION

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01330.
- ☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01330.
- ☐ Substitution rejected - Use specified materials.
- ☐ Substitution Request received too late - Use specified materials.

Signed by: _____

Date: _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ _____

ARCHITECT'S SUPPLEMENTAL INSTRUCTIONS FORM – AIA DOCUMENT G710-2017

AIA Document G710-2017 Supplemental Instructions attached shall be utilized on this project.

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AIA[®] Document G710[™] – 2017

Architect's Supplemental Instructions

PROJECT: *(name and address)*

CONTRACT INFORMATION:
Contract For: General Construction
Date:

ASI INFORMATION:
ASI Number: 001
Date:

OWNER: *(name and address)*

ARCHITECT: *(name and address)*

CONTRACTOR: *(name and address)*

The Contractor shall carry out the Work in accordance with the following supplemental instructions without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates your acknowledgment that there will be no change in the Contract Sum or Contract Time.

(Insert a detailed description of the Architect's supplemental instructions and, if applicable, attach or reference specific exhibits.)

ISSUED BY THE ARCHITECT:

ARCHITECT *(Firm name)*

SIGNATURE

PRINTED NAME AND TITLE

DATE

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CONSTRUCTION CHANGE DIRECTIVE FORM – AIA DOCUMENT G714-2017

AIA Document G714-2017 Construction Change Directive attached shall be utilized on this project.

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AIA® Document G714™ – 2017

Construction Change Directive

PROJECT: *(name and address)*

CONTRACT INFORMATION:
Contract For: General Construction
Date:

CCD INFORMATION:
Directive Number: 001
Date:

OWNER: *(name and address)*

ARCHITECT: *(name and address)*

CONTRACTOR: *(name and address)*

The Contractor is hereby directed to make the following change(s) in this Contract:
(Insert a detailed description of the change and, if applicable, attach or reference specific exhibits.)

PROPOSED ADJUSTMENTS

1. The proposed basis of adjustment to the Contract Sum or Guaranteed Maximum Price is:

- ☒ Lump Sum decrease of \$0.00
- ☐ Unit Price of \$ per
- ☐ Cost, as defined below, plus the following fee:
(Insert a definition of, or method for determining, cost)

☐ As follows:

2. The Contract Time is proposed to remain unchanged. The proposed adjustment, if any, is (0 days).

NOTE: The Owner, Architect and Contractor should execute a Change Order to supersede this Construction Change Directive to the extent they agree upon adjustments to the Contract Sum, Contract Time, or Guaranteed Maximum price for the change(s) described herein.

When signed by the Owner and Architect and received by the Contractor, this document becomes effective IMMEDIATELY as a Construction Change Directive (CCD), and the Contractor shall proceed with the change(s) described above.

Contractor signature indicates agreement with the proposed adjustments in Contract Sum and Contract Time set forth in this CCD.

ARCHITECT *(Firm name)*

OWNER *(Firm name)*

CONTRACTOR *(Firm name)*

SIGNATURE

SIGNATURE

SIGNATURE

PRINTED NAME AND TITLE

PRINTED NAME AND TITLE

PRINTED NAME AND TITLE

DATE

DATE

DATE

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PROPOSAL REQUEST FORM – AIA DOCUMENT G709-2018

AIA Document G709 Proposal Request attached shall be utilized on this project.

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AIA[®] Document G709[™] – 2018

Proposal Request

PROJECT: *(name and address)*
TEST

CONTRACT INFORMATION:
Contract For: General Construction
Date:

Architect's Project Number:
Proposal Request Number: 001
Proposal Request Date:

OWNER: *(name and address)*

ARCHITECT: *(name and address)*

CONTRACTOR: *(name and address)*

The Owner requests an itemized proposal for changes to the Contract Sum and Contract Time for proposed modifications to the Contract Documents described herein. The Contractor shall submit this proposal within Zero (0) days or notify the Architect in writing of the anticipated date of submission.

(Insert a detailed description of the proposed modifications to the Contract Documents and, if applicable, attach or reference specific exhibits.)

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

REQUESTED BY THE ARCHITECT:

PRINTED NAME AND TITLE

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CHANGE ORDER FORM – AIA DOCUMENT G701-2017

AIA Document G701 - Change Order attached shall be utilized on this project.

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Document G701™ – 2017

Change Order

PROJECT: *(Name and address)*

CONTRACT INFORMATION:

Contract For: General Construction

Date:

CHANGE ORDER INFORMATION:

Change Order Number: 001

Date:

OWNER: *(Name and address)*

ARCHITECT: *(Name and address)*

CONTRACTOR: *(Name and address)*

THE CONTRACT IS CHANGED AS FOLLOWS:

(Insert a detailed description of the change and, if applicable, attach or reference specific exhibits. Also include agreed upon adjustments attributable to executed Construction Change Directives.)

The original Contract Sum was	\$	0.00
The net change by previously authorized Change Orders	\$	0.00
The Contract Sum prior to this Change Order was	\$	0.00
The Contract Sum will be increased by this Change Order in the amount of	\$	0.00
The new Contract Sum including this Change Order will be	\$	0.00

The Contract Time will be increased by Zero (0) days.

The new date of Substantial Completion will be

NOTE: This Change Order does not include adjustments to the Contract Sum or Guaranteed Maximum Price, or the Contract Time, that have been authorized by Construction Change Directive until the cost and time have been agreed upon by both the Owner and Contractor, in which case a Change Order is executed to supersede the Construction Change Directive.

NOT VALID UNTIL SIGNED BY THE ARCHITECT, CONTRACTOR AND OWNER.

ARCHITECT *(Firm name)*

CONTRACTOR *(Firm name)*

OWNER *(Firm name)*

SIGNATURE

SIGNATURE

SIGNATURE

PRINTED NAME AND TITLE

PRINTED NAME AND TITLE

PRINTED NAME AND TITLE

DATE

DATE

DATE

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ALLOWANCE AUTHORIZATION FORM

Allowance Authorization Form attached shall be utilized on this project.

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ALLOWANCE AUTHORIZATION

Project:

Engineer:

Project No.:

Contractor:

AAA No.:

Initiation Date:

The Allowance is allocated as follows:

Total original Contract Allowance was:	\$
Amount of Contract Allowance Access previously authorized:	\$
Adjusted Contract Allowance prior to this authorization is:	\$
The amount of available allowance will decrease by this Access Authorization:	\$
The remaining Contract Allowance, after this Access Authorization will be:	\$

Recommended by:
Engineer

By (Signature): _____

Date: _____

Accepted by:
Contractor

Approved by:
Owner

By (Signature): _____ By (Signature): _____

Date: _____ Date: _____

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CERTIFICATE OF SUBSTANTIAL COMPLETION FORM – AIA DOCUMENT G704-2017

AIA Document G704-2017 Certificate of Substantial Completion Form attached shall be utilized on this project.

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AIA[®] Document G704[™] – 2017

Certificate of Substantial Completion

PROJECT: *(name and address)*

CONTRACT INFORMATION:

Contract For: General Construction

Date:

CERTIFICATE INFORMATION:

Certificate Number: 001

Date:

OWNER: *(name and address)*

ARCHITECT: *(name and address)*

CONTRACTOR: *(name and address)*

The Work identified below has been reviewed and found, to the Architect's best knowledge, information, and belief, to be substantially complete. Substantial Completion is the stage in the progress of the Work when the Work or designated portion is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use. The date of Substantial Completion of the Project or portion designated below is the date established by this Certificate.
(Identify the Work, or portion thereof, that is substantially complete.)

ARCHITECT *(Firm Name)*

SIGNATURE

PRINTED NAME AND TITLE

DATE OF SUBSTANTIAL COMPLETION

WARRANTIES

The date of Substantial Completion of the Project or portion designated above is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below:

(Identify warranties that do not commence on the date of Substantial Completion, if any, and indicate their date of commencement.)

WORK TO BE COMPLETED OR CORRECTED

A list of items to be completed or corrected is attached hereto, or transmitted as agreed upon by the parties, and identified as follows:

(Identify the list of Work to be completed or corrected.)

The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. Unless otherwise agreed to in writing, the date of commencement of warranties for items on the attached list will be the date of issuance of the final Certificate of Payment or the date of final payment, whichever occurs first. The Contractor will complete or correct the Work on the list of items attached hereto within () days from the above date of Substantial Completion.

Cost estimate of Work to be completed or corrected: \$

The responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work, insurance, and other items identified below shall be as follows:

(Note: Owner's and Contractor's legal and insurance counsel should review insurance requirements and coverage.)

The Owner and Contractor hereby accept the responsibilities assigned to them in this Certificate of Substantial Completion:

CONTRACTOR *(Firm Name)*

SIGNATURE

PRINTED NAME AND TITLE

DATE

OWNER *(Firm Name)*

SIGNATURE

PRINTED NAME AND TITLE

DATE

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AFFIDAVIT OF PAYMENT OF DEBTS AND CLAIMS FORM – AIA DOCUMENT G706-1994

AIA Document G706 Affidavit of Payment of Debts and Claims Form attached shall be utilized on this project.

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AIA[®] Document G706[™] – 1994

Contractor's Affidavit of Payment of Debts and Claims

PROJECT: <i>(Name and address)</i>	ARCHITECT'S PROJECT NUMBER:	OWNER: ☐
		ARCHITECT: ☐
TO OWNER: <i>(Name and address)</i>	CONTRACT FOR: General Construction	CONTRACTOR: ☐
	CONTRACT DATED:	SURETY: ☐
		OTHER: ☐

STATE OF:
COUNTY OF:

The undersigned hereby certifies that, except as listed below, payment has been made in full and all obligations have otherwise been satisfied for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced above for which the Owner or Owner's property might in any way be held responsible or encumbered.

EXCEPTIONS:

SUPPORTING DOCUMENTS ATTACHED HERETO:

1. Consent of Surety to Final Payment. Whenever Surety is involved, Consent of Surety is required. AIA Document G707, Consent of Surety, may be used for this purpose

Indicate Attachment ☐ Yes ☒ No

The following supporting documents should be attached hereto if required by the Owner:

1. Contractor's Release or Waiver of Liens, conditional upon receipt of final payment.
2. Separate Releases or Waivers of Liens from Subcontractors and material and equipment suppliers, to the extent required by the Owner, accompanied by a list thereof.
3. Contractor's Affidavit of Release of Liens (AIA Document G706A).

CONTRACTOR: *(Name and address)*

BY:

(Signature of authorized representative)

(Printed name and title)

Subscribed and sworn to before me on this date:

Notary Public:
My Commission Expires:

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AFFIDAVIT OF RELEASE OF LIENS FORM – AIA DOCUMENT G706A-1994

AIA Document G706A-1994 - Affidavit of Release of Liens Form attached shall be utilized on this project.

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AIA[®] Document G706A[™] – 1994

Contractor's Affidavit of Release of Liens

PROJECT: <i>(Name and address)</i> TEST	ARCHITECT'S PROJECT NUMBER:	OWNER: ☐
	CONTRACT FOR: General Construction	ARCHITECT: ☐
TO OWNER: <i>(Name and address)</i>	CONTRACT DATED:	CONTRACTOR: ☐
		SURETY: ☐
		OTHER: ☐

STATE OF:
COUNTY OF:

The undersigned hereby certifies that to the best of the undersigned's knowledge, information and belief, except as listed below, the Releases or Waivers of Lien attached hereto include the Contractor, all Subcontractors, all suppliers of materials and equipment, and all performers of Work, labor or services who have or may have liens or encumbrances or the right to assert liens or encumbrances against any property of the Owner arising in any manner out of the performance of the Contract referenced above.

EXCEPTIONS:

SUPPORTING DOCUMENTS ATTACHED HERETO:

1. Contractor's Release or Waiver of Liens, conditional upon receipt of final payment.
2. Separate Releases or Waivers of Liens from Subcontractors and material and equipment suppliers, to the extent required by the Owner, accompanied by a list thereof.

CONTRACTOR: *(Name and address)*

BY:

*(Signature of authorized
representative)*

(Printed name and title)

Subscribed and sworn to before me on this date:

Notary Public:

My Commission Expires:

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CONSENT OF SURETY TO FINAL PAYMENT FORM – AIA DOCUMENT G707-1994

AIA Document G707-1994 - Consent of Surety to Final Payment Form attached shall be utilized on this project.

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AIA[®] Document G707[™] – 1994

Consent Of Surety to Final Payment

PROJECT: <i>(Name and address)</i> TEST	ARCHITECT'S PROJECT NUMBER:	OWNER: ☐
	CONTRACT FOR: General Construction	ARCHITECT: ☐
TO OWNER: <i>(Name and address)</i>	CONTRACT DATED:	CONTRACTOR: ☐
		SURETY: ☐
		OTHER: ☐

In accordance with the provisions of the Contract between the Owner and the Contractor as indicated above, the
(Insert name and address of Surety)

on bond of
(Insert name and address of Contractor)

, SURETY,

hereby approves of the final payment to the Contractor, and agrees that final payment to the Contractor shall
not relieve the Surety of any of its obligations to
(Insert name and address of Owner)

, CONTRACTOR,

as set forth in said Surety's bond.

, OWNER,

IN WITNESS WHEREOF, the Surety has hereunto set its hand on this date:
(Insert in writing the month followed by the numeric date and year.)

(Surety)

(Signature of authorized representative)

(Printed name and title)

Attest:
(Seal):

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**GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION – AIA DOCUMENT
A201-2017**

The General Conditions of this Contract are as stated in the American Institute of Architects Document AIA A201 (2017 Edition) entitled General Conditions of the Contract for Construction and is part of this project manual as if herein written in full.

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AIA® Document A201™ – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

THE OWNER:
(Name, legal status and address)

THE ARCHITECT:
(Name, legal status and address)

TABLE OF ARTICLES

- 1 GENERAL PROVISIONS
- 2 OWNER
- 3 CONTRACTOR
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- 5 SUBCONTRACTORS
- 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS
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- 11 INSURANCE AND BONDS
- 12 UNCOVERING AND CORRECTION OF WORK
- 13 MISCELLANEOUS PROVISIONS
- 14 TERMINATION OR SUSPENSION OF THE CONTRACT
- 15 CLAIMS AND DISPUTES

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. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

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

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 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 only to the extent

consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. The parties will use AIA Document E203™-2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, 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 in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements,

assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 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. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- .1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- .3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the

Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the

Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations

and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 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. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor,

prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- .1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- .2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

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 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work,

promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

- .1 The change in the Work;
- .2 The amount of the adjustment, if any, in the Contract Sum; and
- .3 The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- .1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- .2 Unit prices stated in the Contract Documents or subsequently agreed upon;
- .3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- .4 As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

- .1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;
- .2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
- .3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- .4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
- .5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will

affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and binding dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and

unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1 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, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, 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 if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- .3 failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a Separate Contractor;
- .6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
- .7 repeated failure to carry out the Work in accordance with the Contract Documents.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven 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

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 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 is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- .1 liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- .2 failure of the Work to comply with the requirements of the Contract Documents;
- .3 terms of special warranties required by the Contract Documents; or
- .4 audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

- .1 employees on the Work and other persons who may be affected thereby;
- .2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
- .3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 **Notice of Cancellation or Expiration of Contractor's Required Insurance.** Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.2.2 **Failure to Purchase Required Property Insurance.** If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.

§ 11.2.3 **Notice of Cancellation or Expiration of Owner's Required Property Insurance.** Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§ 11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to

the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties 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.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- .1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped;
- .3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- .4 The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

- .1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;
- .2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;
- .3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- .4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 Accept assignment of subcontracts pursuant to Section 5.4; and
- .3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance,

the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- .1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or
- .2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

- .1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
- .2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the

Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ 15.3.3 Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ 15.4 Arbitration

§ 15.4.1 If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ 15.4.4 Consolidation or Joinder

§ 15.4.4.1 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ 15.4.4.2 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.

Additions and Deletions Report for AIA® Document A201™ – 2017

This Additions and Deletions Report, as defined on page 1 of the associated document, reproduces below all text the author has added to the standard form AIA document in order to complete it, as well as any text the author may have added to or deleted from the original AIA text. Added text is shown underlined. Deleted text is indicated with a horizontal line through the original AIA text.

Note: This Additions and Deletions Report is provided for information purposes only and is not incorporated into or constitute any part of the associated AIA document. This Additions and Deletions Report and its associated document were generated simultaneously by AIA software at 15:44:45 ET on 05/31/2019.



Certification of Document's Authenticity

AIA® Document D401™ – 2003

I, , hereby certify, to the best of my knowledge, information and belief, that I created the attached final document simultaneously with its associated Additions and Deletions Report and this certification at 15:44:45 ET on 05/31/2019 under Order No. 1840604654 from AIA Contract Documents software and that in preparing the attached final document I made no changes to the original text of AIA® Document A201™ - 2017, General Conditions of the Contract for Construction, as published by the AIA in its software, other than those additions and deletions shown in the associated Additions and Deletions Report.

(Signed)

(Title)

(Dated)

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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

1. GENERAL PROVISIONS
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 State of Delaware, Division of Facilities Management 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 OWNER'S 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 ensure 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: ARCHITECT

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 STATE OF DELAWARE DIVISION OF FACILITIES MANAGEMENT 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”.

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 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 FINAL COMPLETION AND FINAL PAYMENT

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 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 State 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 CLAIMS

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.

ARTICLE 16 - LIQUIDATED DAMAGES

16.1 "It is expressly understood and agreed by and between the Contractor and the Owner that the Contract time stipulated in the bid form is a reasonable time for completion of the work, taking into consideration the average climatic range and the usual conditions prevailing in the locality of the project. Time is an essential element of the contract and it is important that the work be vigorously prosecuted and conform to the scheduled start and finish dates of the Construction Documents."

16.2 "The Contractor agrees that he can and will substantially complete the total projects work in accordance with the Contract Documents within the stated Contract Time."

16.3 "The Owner and Contractor agree that due to the uniqueness of this contract and the fact that the Owner is a private agency and the relevant factors, damages resulting from failure of the Contractor to perform the contract within the time specified therefore will result in damages to the Owner which shall be difficult, if

not impossible, to ascertain; therefore, the provision for damages herein specified shall be applied in the event of such a default. The Owner and the Contractor, both of whom are, by their own admissions, sophisticated business entities with prior experience in dealing with construction contracts, stipulate that damages shall be the sum of \$500.00 for each day that the work shall remain uncompleted beyond the time(s) specified elsewhere in the contract, provided, however, that due account shall be taken of any adjustment of specified completion time(s) for completion of work as granted by approved change orders."

- 16.4 "The Contractor, by the execution of the contract document, does hereby irrevocably constitute, designate and appoint the Owner to be his agent for the limited but express purpose of deducting on a daily basis the liquidated damages as above determined from the balance of the contract funds in the hands of the Owner and due to the Contractor, and the failure of the Owner to deduct such sum for any day or any combination of days, whether consecutive or not, shall not operate as a waiver of such liquidated damages for that period, and such damages for such day or days shall be cumulative and may be subsequently deducted by the Owner from such sums as may be due the Contractor, but work performed. In the event that the amounts due the Contractor are less than the amount of such damages, the Contractor, shall be liable to the Owner for the difference."
- 16.5 "The power granted by the Contractor to the Owner above is a power coupled with an interest and is irrevocable."

END OF SUPPLEMENTARY GENERAL CONDITIONS

WAGE RATE DETERMINATION SCHEDULE

Enclosed is a copy of the State of Delaware Wage Rate Determination Schedule that shall be utilized on this project.

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STATE OF DELAWARE
DEPARTMENT OF LABOR
OFFICE OF CONSTRUCTION INDUSTRY ENFORCEMENT
655 SOUTH BAY ROAD
SUITE 2H
DOVER, DELAWARE 19901

Via Electronic and Regular Mail

October 24, 2024

Mr. R. Adam Kegan
Gipe Associates, Inc.
8719 Brooks Drive
Easton, MD 21601

Re: SRS 2503 Magnolia Middle School -HVAC Renovations ,Kent County, DE

Dear Mr. Kegan:

I am responding to your request for a category determination for Contract number SRS 2503 Magnolia Middle School -HVAC Renovations , which is a state funded construction project located in Kent County, DE. The work consists of replace Rooftop Air Handling Units #2 and #4. You estimate the total cost of construction for this project to be \$6,153,002.00.

Based upon the information you provided the Department of Labor has determined that this project is a Building Construction project.

Delaware's Prevailing Wage Regulations provide that the rates applicable to a project are the rates in effect on the date of publication of the specifications for that project. I have enclosed a certified copy of the prevailing wage rates effective, March 15, 2024, which amended June 14, 2024 for Building Construction to be included in your bid specification. However, please be advised that, in the event that a contract for a project is not executed within one hundred and twenty (120) days from the earliest date the specifications were published, the rates in effect at the time of the execution of the contract shall be the applicable rates for the project.

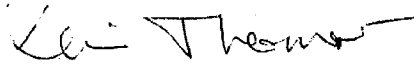
This determination is directed solely to the parties identified herein. It is based on the unique facts relevant to this matter. It does not constitute precedent and should not be cited as such by future parties.

Pursuant to 19 Del. Chapter 36, all contractors must obtain their Contractor Registration Certificate prior to performing construction services or maintenance work throughout Delaware. Contractors can submit an application by visiting the Delaware One Stop https://onestop.delaware.gov/Operate_Contractors.

Lastly, please see the enclosed debarment list. Entities/individuals listed shall not be permitted to bid on, be awarded or work on Delaware State funded construction projects, in the timeframe specified, as provided for under 29 Del.C.6960 or other applicable State statutes.

If you have any questions or I can provide any additional assistance, please do not hesitate to contact me at (302) 430-7719.

Sincerely,

A handwritten signature in black ink, appearing to read "Kevin Thomas", with a stylized flourish at the end.

KEVIN THOMAS
(302) 430-7719
KEVIN.THOMAS@DELAWARE.GOV

Enclosures

STATE OF DELAWARE
DEPARTMENT OF LABOR
DIVISION OF INDUSTRIAL AFFAIRS OFFICE
CONSTRUCTION INDUSTRY ENFORCEMENT
PHONE: (302) 318-2769

Mailing Address:
252 Chapman Road
Suite 210
Newark, DE 19702

Located at:
252 Chapman Road
Suite 210
Newark, DE 19702

PREVAILING WAGES FOR BUILDING CONSTRUCTION
EFFECTIVE MARCH 15, 2024 – AMENDED JUNE 14, 2024

CLASSIFICATION	NEW CASTLE	KENT	SUSSEX
ASBESTOS WORKERS	29.03	35.74	52.03
BOILERMAKERS	86.90	44.09	64.81
BRICKLAYERS	65.24	65.24	65.24
CARPENTERS	61.06	61.06	49.30
CEMENT FINISHERS	91.66	65.19	50.55
ELECTRICAL LINE WORKERS	57.72	49.50	37.74
ELECTRICIANS	81.62	81.62	81.62
ELEVATOR CONSTRUCTORS	113.66	81.88	103.45
GLAZIERS	83.30	83.30	71.92
INSULATORS	67.20	67.20	67.20
IRON WORKERS	75.32	75.32	75.32
LABORERS	55.65	55.65	55.65
MILLWRIGHTS	85.36	85.36	68.57
PAINTERS	57.60	57.60	57.60
PILEDRIERS	88.62	49.97	40.41
PLASTERERS	37.89	37.89	28.08
PLUMBERS/PIPEFITTERS/STEAMFITTERS	77.30	80.57	71.11
POWER EQUIPMENT OPERATORS	81.29	81.29	81.29
ROOFERS-COMPOSITION	29.45	29.41	31.82
ROOFERS-SHINGLE/SLATE/TILE	23.34	27.77	21.83
SHEET METAL WORKERS	84.53	84.53	84.53
SOFT FLOOR LAYERS	60.12	60.12	60.12
SPRINKLER FITTERS	70.52	70.52	70.52
TERRAZZO/MARBLE/TILE FNRS	70.79	70.79	79.54
TERRAZZO/MARBLE/TILE STRS	78.73	78.73	88.22
TRUCK DRIVERS	55.25	34.83	27.11

CERTIFIED: 10/25/2024

BY: [Signature] / For Fran Chudzik
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, CLASSIFICATIONS, PHONE (302) 318-2769.

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

PROJECT: SRS 2503 Magnolia School District – HVAC Renovations, Kent County.



PREVAILING WAGE DEBARMENT LIST

The following contractors have been debarred for violations of the prevailing wage law 29Del.C. §6960 or other applicable State statutes.

Therefore, no public construction contract in this State shall be bid on, awarded to, or received by contractors and individuals on this list for a period of (3) three years from the date of the judgment or as deemed by a court of competent jurisdiction.

Contractor	Address	Date of Debarment
Mullen Brothers, Inc. and Daniel Mullen, individually	3375 Garnett Road, Boothwyn, PA 19060	Indefinite/ Civil Contempt
State Contractors Corporation, and Jose Oscar Rivera, individually	13004 Hathaway Drive Silver Spring, MD 20906	Indefinite/ 19 <u>Del.C. 2374(f)</u>
Green Granite and Jason Green, individually	604 Heatherbrooke Court Avondale, PA 19311	Indefinite/ Civil Contempt
Pro Image Landscaping, Inc. and Owner(s) individually	23 Commerce Street Wilmington, DE 19801 and/or 2 Cameo Road Claymont, DE 19703	Indefinite/19 <u>Del.C. §108 & 10 Del.C. 542(c)</u>
Liberty Mechanical, LLC and Owner(s), individually	2032 Duncan Road Wilmington, DE 19801	Indefinite/ 19 <u>Del.C. 2374(f)</u>
Integrated Mechanical and Fire Systems Inc. and Allison Sheldon, individually	4601 Governor Printz Boulevard Wilmington, DE 19809	Indefinite/19 <u>Del.C. §108 & 10 Del.C. 542(c)</u>
ACH 1, INC.	873 Salem Church Road Newark, DE 19702	Indefinite/19 <u>Del.C.6960</u>

Updated: July 6, 2022

GENERAL REQUIREMENTS

TABLE OF ARTICLES

1. GENERAL PROVISIONS
2. OWNER
3. CONTRACTOR
4. ADMINISTRATION OF THE CONTRACT
5. SUBCONTRACTORS
6. CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS
7. CHANGES IN THE WORK
8. TIME
9. PAYMENTS AND COMPLETION
10. PROTECTION OF PERSONS AND PROPERTY
11. INSURANCE AND BONDS
12. UNCOVERING AND CORRECTION OF WORK
13. MISCELLANEOUS PROVISIONS
14. TERMINATION OR SUSPENSION OF THE CONTRACT

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 materiel or performing labor in the performance of the Contract, of all sums of money due the person for such labor and materiel. (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 require, 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 Engineer. 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, Engineer 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 and met the requirements of substantial completion, but still requires small items of miscellaneous work, the Engineer 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 Engineer will not be required to participate in or to perform this operation. Upon completion of this work, the Owner will notify the Contractor and Engineer 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, shall not 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	for each person
	\$1,000,000	for each occurrence
	\$1,000,000	aggregate
Property Damage	\$500,000	for each occurrence
	\$1,000,000	aggregate

11.7.2 Contractor's Protective Liability Insurance

Minimum coverage to be:

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

11.7.3 Automobile Liability Insurance

Minimum coverage to be:

Bodily Injury	\$1,000,000	for each person
	\$1,000,000	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

DRUG TESTING FORMS

Pursuant to 4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors who work on Large Public Works Contracts funded all or in part with public funds submit Testing Report Forms to the Owner no less than quarterly. See the form attached hereto.

The Contractor will notify the Owner in writing of any positive results of random drug testing. See the form attached hereto. The results must be reported to the Owner within 24 hours of receipt of the test results.

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DRUG TESTING FORMS

EMPLOYEE DRUG TESTING REPORT FORM

Period Ending:

4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors who work on Large Public Works Contracts funded all or in part with public funds submit Testing Report Forms to the Owner no less than quarterly.

Project Number: _____

Project Name: _____

Contractor/Subcontractor Name: _____

Contractor/Subcontractor Address: _____

Number of employees who worked on the jobsite during the report period: _____

Number of employees subject to random testing during the report period: _____

Number of Negative Results _____ Number of Positive Results _____

Action taken on employee(s) in response to a failed or positive random test:

Authorized Representative of Contractor/Subcontractor: _____
(typed or printed)

Authorized Representative of Contractor/Subcontractor: _____
(signature)

Date: _____

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**EMPLOYEE DRUG TESTING
REPORT OF POSITIVE RESULTS**

4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors who work on Large Public Works Contracts funded all or in part with public funds to notify the Owner in writing of a positive random drug test.

Project Number: _____

Project Name: _____

Contractor/Subcontractor Name: _____

Contractor/Subcontractor Address: _____

Name of employee with positive test result: _____

Last 4 digits of employee SSN: _____

Date test results received: _____

Action taken on employee in response to a positive test result:

Authorized Representative of Contractor/Subcontractor: _____
(typed or printed)

Authorized Representative of Contractor/Subcontractor: _____
(signature)

Date: _____

This form shall be sent by mail to the Owner within 24 hours of receipt of test results.

Enclose this test results form in a sealed envelope with the notation "Drug Testing Form – DO NOT OPEN" on the face thereof and place in a separate mailing envelope.

END OF SECTION

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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

1.0 Purpose

The Office of Management and Budget ("Office"), has developed these regulations that require Contractors and Subcontractors to implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds pursuant to 29 Del.C. §6908(a)(6). The regulations establish the mechanism, standards and requirements of a Mandatory Drug Testing Program that will be incorporated by reference into all Large Public Works Contracts awarded pursuant to 29 Del.C. §6962.

2.0 Definitions

"Contractor" means an entity such as, but not limited to, an individual, firm, partnership or corporation that has a contractual obligation to perform work for contracts awarded pursuant to 29 Del.C. §6962.

"Division of Facilities Management" and **"DFM"** means the Division of Facilities Management within the Office of Management and Budget.

"Drug Testing Firm" is an entity engaged in the business of providing drug testing services for businesses, individuals, governments or any entity that requires drug testing of Employees, applicants, licensees, etc., in compliance with these requirements.

"Employee" means an individual employed by a Contractor or Subcontractor who works on the Jobsite of a Large Public Works Contract but does not fulfill a clerical or administrative function. For the purpose of this definition, clerical or administrative functions shall refer to job responsibilities that do not generally require an employee to work outside of the Contractor's Jobsite office, home office or other employer-provided office. For the purposes of this regulation, the term "Employee" shall also include supervisors and foremen working on the Jobsite. The term "Employee" shall also include delivery personnel employed by a Contractor or Subcontractor working on or delivering materials and equipment to and from a Jobsite.

"Impairment" or "Impaired" means symptoms that an Employee while working may be under the influence of drugs or alcohol that may decrease or lessen the Employee's performance of the duties or tasks of the Employee's job position, including symptoms of the Employee's speech, walking, standing, physical dexterity, agility, coordination, actions, movement, demeanor, appearance, clothing, odor, irrational or unusual behavior, negligence or carelessness in operating equipment, machinery or production or manufacturing processes, disregard for the safety of the Employee or others, or other symptoms causing a reasonable suspicion of the use of drugs or alcohol.

"Jobsite" means the site or area directly or indirectly owned, operated or controlled by the Owner in which the Contractor or Subcontractor performs work or delivers services to the Owner. For the purpose of this definition, "Jobsite" does not mean a remote work site not under the direct or indirect control of the Owner in which work is performed to fulfill the Contractor's or Subcontractor's obligations.

"Large Public Works Contract" means a contract for a public works construction awarded pursuant to 29 Del.C. §6962.

"Mandatory Drug Testing Program" and **"Program"** means a defined set of basic procedures, requirements and rules that must be used by a Contractor or Subcontractor to test Employees for drugs in compliance with these requirements.

"Owner" is the state agency, school district or entity that awards a Large Public Works Contract to a Contractor pursuant to 29 Del.C. §6962.

"Positive Test Result" and **"Fail a Drug Test"** means the result reported by a Health and Human Services certified laboratory when a specimen contains a drug or drug metabolite equal to or greater than the cutoff concentration. For purposes of these regulations, an Employee shall not be considered to have a Positive Test Result nor shall an Employee be considered to "Fail a Drug Test" if:

- The Employee is a Registered Qualifying Patient and;
- The drug detected was marijuana, a component of marijuana, or marijuana metabolites.

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"Random Drug Testing" means that an Employee is chosen at random for testing without advance notice, from a pool of Employees working on the Jobsite. Specific requirements for random drug testing conducted under these regulations are described in Section 5.0.

"Registered Qualifying Patient" means a person (1) validly issued and in possession of an unexpired Registry Identification Card as defined by 16 Del.C. §4902A (14), and (2) subject to confirmation through a "verification system" as set forth at 16 Del.C. §4902A(17).

"Subcontractor" means an entity such as, but not limited to, an individual, firm, partnership or corporation that has a contractual obligation to perform work for, or supply services to a Contractor as defined in section 2.1.

"Testing Result Forms" means a form summarizing drug testing completed monthly by the Contractor and Subcontractor and submitted to the Owner in accordance with requirements contained in the bid solicitation.

3.0 Employee drug testing documentation requirements.

3.1 The following documentation requirements apply:

3.1.1 At bid submission - A solicitation for a Large Public Works Contract must require each Contractor that submits a bid for the work to submit with the bid signed individual affidavit(s) for the Contractor and each listed Subcontractor certifying that the Contractor and Subcontractor has in place or will implement during the entire term of the contract a Mandatory Drug Testing Program for their Employees that complies with this regulation.

3.1.2 Two business days prior to contract execution – The awarded Contractor shall provide to the Owner copies of the Employee Drug Testing Program for the Contractor and for all listed Subcontractors.

3.1.3 During contract execution – Contractors that employ additional Subcontractors on the jobsite may do so only after submitting a copy of the Subcontractor's Employee Drug Testing Program. A Contractor or Subcontractor shall not commence work until the Owner has concluded the Employee Drug Testing Program complies with this Regulation as per Section 3.2.

3.1.4 In the event of an emergency a Contractor may employ additional Subcontractors on the jobsite prior to submitting the Subcontractor's Employee Drug Testing Program provided that said Program is submitted to the Owner as soon as practicable.

3.2 A Contractor or Subcontractor shall be treated as having a Mandatory Drug Testing Program that complies with this regulation if the Program includes the following:

3.2.1 The Program meets the minimum standards in section 4.0 of this regulation.

3.2.2 The Program provides for the frequency of testing of Employees as per section 5.0 of this regulation:

3.2.3 The Program imposes disciplinary measures on an Employee who fails a drug test as per section 6.0 of this regulation.

3.3 Prequalified Contractors and Subcontractors – A Contractor or Subcontractor may meet the provisions of Section 3.1 if they are Prequalified through the DFM Prequalification and if the DFM Prequalification includes provisions requiring an Employee Mandatory Drug Testing Program that meet the requirements of Sections 4.0, 5.0 and 6.0 of this Regulation

3.4 The State shall not be obligated to pay, and the Contractor or Subcontractor shall expressly agree that, any portion of work performed by a Contractor or Subcontractor commenced before that Contractor or Subcontractor has complied with Sections 3.1 and 3.2, provided however that emergency work as referenced in 3.1.4 may not be subject to this provision.

4.0 Minimum Standards for a Mandatory Drug Testing Program

4.1 Testing for the presence of drugs in an Employee's system and the handling of test specimens shall be conducted in accordance with guidelines for the collection, chain-of-custody procedures, laboratory testing, and Medical Officer Review procedures contained within the Mandatory Guidelines for Federal Workplace Drug Testing Programs published by the Substance Abuse and Mental Health Services Administration (SAMHSA). http://workplace.samhsa.gov/DrugTesting/Level_1_Pages/mandatory_guidelines5_1_10.html

All tests must be processed by a federal Health and Human Services certified laboratory. Contractors must provide documentation detailing the procedures used in the collection, testing and reporting of drug tests sufficient to show conformance with SAMHSA guidelines.

4.2 Contractors and Subcontractors subject to these regulations may procure the services of an appropriate Drug Testing Firm to administer their program. A Contractor or Subcontractor may also implement a Mandatory Drug

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Testing Program using in-house personnel and resources. However a Contractor or Subcontractor doing so shall have to demonstrate that the program meets or exceeds the requirements specified herein to the satisfaction of the Owner.

- 4.3 Employees subject to drug testing shall be tested using at a minimum a seven-panel protocol testing plus alcohol screening for the following:

Substance	Common Name	Cutoff
Marijuana metabolite		50 ng/ml
Cocaine metabolite		150 ng/ml
Opiate metabolite		2000 ng/ml
Acetylmorphine	Heroin metabolite	10 ng/ml
Phencyclidine	PCP	25 ng/ml
Amphetamines (including Methamphetamines)	Meth	500 ng/ml
MDMA	Ecstasy	250 ng/ml
Alcohol		0.04% BAC

- 4.4 The frequency of Random Drug Testing and the methodology for selecting Employees to be screened are defined in section 5.0 and shall be incorporated into Contractor and Subcontractor mandatory testing procedures. A Contractor or Subcontractor may incorporate rules or requirements that exceed the requirements defined herein.

5.0 Drug Testing Requirements – Frequency for the Testing of Employees

- 5.1 Initial Drug Testing - Employees commencing work on a Jobsite must be tested with the exception that an Employee who has passed a random or scheduled drug test within the past 60 days from the date of commencing work shall be permitted to work at the Jobsite without further testing; however, the Employee is still subject to random testing.
- 5.2 Random Drug Testing - During the course of a project, each Contractor and Subcontractor with Employees on the Jobsite shall implement Random Drug Testing according to the following requirements.
- 5.2.1 All Employees will be subject to random, unannounced testing.
- 5.2.2 The selection of Employees shall be made by a scientifically valid method of randomly generating an Employee identifier from a Contractor or Sub-contractor's pool of Employees.
- 5.2.3 No less than 10% of a Contractor's or Subcontractor's anticipated workforce based on construction schedules validated by certified payrolls shall be randomly selected each month for testing. Contractors or Subcontractors with less than 10 Employees shall test at least one of their Employees, selected randomly per month. Each Employee shall have an equal chance of selection each time the selection is made. Because the selection process is random, some Employees may not be tested within a year, while others may be tested more than once.
- 5.2.4 Employees notified that they have been selected must report within four hours for testing to a site specified. Employees so notified must have been given such notification at least four hours before the scheduled closing time of the testing facility. Any failure to report for random testing, or to cooperate with the testing procedure shall be considered a positive result.
- 5.2.5 Purposely impeding or delaying an Employee's fulfillment of the testing requirements herein by a Contractor or Subcontractor may subject the Contractor or Subcontractor to sanctions listed in Section 8.
- 5.3 Reasonable Suspicion Testing – An Employee will be required to take a drug test at any time his or her employing Contractor, Subcontractor or the Owner reasonably believes that he or she has an Impairment caused by drugs and/or alcohol. Further, an Employee may be required to take a drug test at any time his or her employing Contractor, Subcontractor or the Owner finds drug paraphernalia and/or open alcohol containers on the Jobsite.
- 5.4 Return to Duty Testing – As required in Section 6.0.
- 5.5 Accident Triggered Testing – An Employee will be required to take a drug test and may be subject to an onsite alcohol breathalyzer test at any time there is a Jobsite accident involving loss or significant property damage, injury or death to an Employee of the Contractor, Subcontractor, or Owner or member of the public.

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- 5.5.1 As soon as practicable following an accident, the Contractor will notify the Employee(s) whose performance could have contributed to the accident of the need for the test.
- 5.5.2 The appropriate Contractor shall ensure that an Employee, required to be tested under this section, is tested as soon as practicable, but no longer than 4 hours after the accident. Employees so notified must have been given such notification at least four hours before the scheduled closing time of the testing facility. If the drug test is not conducted within 4 hours, attempts to conduct the test must cease and the reasons for the failure to test documented.
- 5.5.3 An Employee who is subject to post-accident testing who fails to remain readily available for such testing, including notifying a supervisor of his or her location if he or she leaves the scene of the accident prior to submission to such test, may be deemed to have refused to submit to testing.
- 5.5.4 If an Employee fails or refuses to be tested, he/she must be removed from the Jobsite.
- 5.5.5 Nothing in this section shall be construed to require the delay of necessary medical attention for the injured following an accident, or to prohibit an Employee from leaving the scene of an accident for the period necessary to obtain assistance in responding to the accident, or to obtain necessary emergency medical care.
- 5.6 All testing required by this section shall be administered according to the standards outlined in Section 4.0.

6.0 Consequences of a Positive Test Result

- 6.1 The disciplinary measures contained within a Contractor's or Subcontractor's drug testing program for an employee who tests positive to a mandatory drug test must include at a minimum, all of the following:
 - 6.1.1 The Employee is subject to an immediate suspension from any public works Jobsite.
 - 6.1.2 The Employee is not eligible for reinstatement by the Contractor or Subcontractor to any public works Jobsite until 30 days after the Employee tests negative on a seven drug panel plus alcohol test certified by a medical review officer.
 - 6.1.3 The Employee is subject to unscheduled monthly random testing for at least one (1) year after reinstatement, or during the term of the Large Public Works Contract, whichever is less.
 - 6.1.4 An Employee who has tested positive for more than one drug test within a three year period shall be permanently banned from working at public works Jobsites.
 - 6.1.5 An Employee who has tested positive for marijuana, a component of marijuana, or marijuana metabolites and is a Registered Qualifying Patient shall be exempted from the disciplinary actions contained in this section unless:
 - 6.1.5.1 The Employee was Impaired by marijuana at the Jobsite
 - 6.1.5.2 Employment of the Registered Qualifying Patient would cause the Owner to lose monetary or licensing-related benefits under Federal law.
- 6.2 A Contractor or Subcontractor shall report the Positive Test Result to the Employee's professional licensing board, if applicable.

7.0 Contractor and Subcontractor Certification of Compliance with Regulations

- 7.1 During the term of the contract:
 - 7.1.1 During the term of the contract, Contractors and Subcontractors shall submit Testing Report Forms to the Owner as set forth herein:
 - 7.1.1.1 The Testing Report Forms shall be submitted to the Owner no less than quarterly.
 - 7.1.1.2 An Owner may require monthly submissions of the Testing Report Forms.
 - 7.1.1.3 A Contractor or Subcontractor that is employed on the Jobsite for less than 30 days shall not be subject to the reporting requirements contained in Sections 7.1.1 and 7.1.2 of this regulation, unless the Owner specifies that such reporting is required in the Invitation to Bid or Specifications relating to the work to be performed.
 - 7.1.2 The forms shall at a minimum contain the following information:
 - 7.1.2.1 The number of Employees who worked on the Jobsite during the previous month.
 - 7.1.2.2 The number of Employees subjected to random testing during the previous month.
 - 7.1.2.3 The number of negative results and the number of positive results.

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7.1.2.4 Action taken by the Contractor or Subcontractor on an Employee who failed or tested positive to a random test.

7.1.3 Testing Result Forms may be submitted electronically to an Owner.

7.1.4 Any Positive Test Result including the Employee name and action taken in response by a Contractor or Subcontractor must be reported by the Contractor or Subcontractor to the Owner within 24 hours of the Contractor or Subcontractor receiving the test results. A Positive Test Result must be submitted to the Owner in writing.

7.1.5 The Owner shall have the right to periodically audit all Contractor and Subcontractor test results at the Contractor or Subcontractor's offices.

7.1.6 The failure to comply with these reporting requirements shall be considered a material breach of any agreement relating to the performance of work by the Contractor or Subcontractor.

8.0 Penalties

8.1 A Contractor or Subcontractor on a Large Public Works contract that fails to implement a Mandatory Drug Testing Program in accordance with this regulation or falsifies testing results shall be subject to the following sanctions:

8.1.1 Written warning (1st offense).

8.1.2 Prohibition from bidding on new public works jobs for a period not to exceed three months (2nd offense) and one year (3rd offense).

8.1.3 For subsequent offenses, debarment or bond revocation.

8.2 Notwithstanding any other provision of this regulation, if any failure to comply with the requirements of this regulation are particularly flagrant or egregious, the Owner may seek a termination for cause, a temporary suspension, a determination that the Contractor or Subcontractor is not responsible, debarment or bond revocation, and any other statutory, common law, or equitable remedy.

19 DE Reg. 207 (09/01/15)

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CAESAR RODNEY SCHOOL DISTRICT - MAGNOLIA MIDDLE SCHOOL – HVAC RENOVATIONS
MAGNOLIA, DELAWARE

**AFFIDAVIT OF
CRAFT TRAINING COMPLIANCE**

We, the contractor, hereby certify that we and all applicable subcontractors will abide by the contractor and subcontractor craft training requirements outlined below for the duration of the contract. Craft training must be provided by a contractor and/or subcontractor for each craft on a project for which there are Delaware Department of Labor approved and registered training programs. A list of crafts for which there are approved and registered training programs is maintained by the Delaware Department of Labor and can be found at [https://det.delawareworks.com/apprenticeship/documents/Apprenticeship Occupation List for 29Del6962 Compliance.pdf](https://det.delawareworks.com/apprenticeship/documents/Apprenticeship%20Occupation%20List%20for%2029Del6962%20Compliance.pdf)

If you have questions regarding craft training programs, please submit them in writing to the Delaware Department of Labor at: apprenticeship@delaware.gov. The Craft Training Compliance Affidavit must be submitted prior to contract execution. In addition to this Affidavit, all information pertaining to craft training for subcontractors must also be submitted prior to contract execution. Information to be provided is the craft, company name, registration number (indicate DE, US DOL or identify other state) or that craft training requirements do not apply and the reason.

In accordance with Title 29, Chapter 69, Section 6962(d)(13) of the Delaware Code, contractors and subcontractors must provide craft training for journeyman and apprentice levels if **all** of the following apply:

- A. A project meets the prevailing wage requirement under Title 29, Chapter 69, Section 6960 of the Delaware Code.
- B. The contractor employs 10 or more total employees.
- C. The project is not a federal highway project

Failure to provide required craft training on the project may subject the successful contractor and/or subcontractor(s) to penalties as outlined in Title 29, Chapter 69, Section 6962(d)(13) of the Delaware Code.

Craft(s)

Contractor Name:

Contractor Address:

Contractor Program

Registration Number(s)

On this line also indicate whether DE, Other State (identify) or US Registration Number

Or

☐ **Craft Training requirements are not applicable because:** _____

Authorized Representative (typed or printed):

Authorized Representative (signature):

Title:

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

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**SECTION 01 11 00
SUMMARY OF WORK
TABLE OF CONTENTS**

PART 1 GENERAL

- 1.1 RELATED DOCUMENTS
- 1.2 SUMMARY
- 1.3 PROJECT INFORMATION
- 1.4 WORK COVERED BY CONTRACT DOCUMENTS
- 1.5 WORK UNDER SEPARATE CONTRACTS
- 1.6 ACCESS TO SITE
- 1.7 COORDINATION WITH OCCUPANTS
- 1.8 WORK RESTRICTIONS
- 1.9 SPECIFICATION AND DRAWING CONVENTIONS

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Work by Owner.
- 4. Access to site.
- 5. Coordination with occupants.
- 6. Work restrictions.
- 7. Specification and drawing conventions.

- B. Related Section:

- 1. Division 01 Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Caesar Rodney School District – Magnolia Middle School – HVAC Renovations.

- 1. Project Location:
 - a. Magnolia Middle School, 133 Thomas More Dr, Magnolia, Delaware 19962.

- B. Owner: Caesar Rodney School District, 7 Front Street, Wyoming, Delaware, 19934.

- 1. Owner's Representative: William James Pennewell, Supervisor of Facilities Management, 302-697-4800, william.pennewell@cr.k12.de.us

- C. M/E/P Engineer: Gipe Associates, Inc., 8719 Brooks Drive, Easton, MD 21601.

- 1. Engineer's Representative: David R. Hoffman, P.E., LEED AP, President, 410-822-8688; dhoffman@gipe.net

1.4 WORK COVERED BY CONTRACT DOCUMENTS

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

1. The HVAC Renovations at the Magnolia Middle School. Project shall include, but not be limited to central chilled and hot water heating system, fan coils, ERV's, SZVAV units, controls, ceilings, ductwork, insulation, piping, testing and balancing, duct detectors, roof work, commissioning, steel/structure, new electrical services, and power connections. Refer to project alternates.

B. Type of Contract

1. Project will be constructed under a single prime contract.

1.5 WORK UNDER SEPARATE CONTRACTS

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

1.6 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to the specific spaces indicated in all three (3) schools.
2. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.7 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.

2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. All finishes and floor must be protected as indicated on Contract Drawing.
- C. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 4:30 p.m., Monday through Friday, except as otherwise indicated.
 1. Weekend Hours: (As approved by the Owner)
 2. Early Morning Hours: (As approved by the Owner)
 3. Hours for Utility Shutdowns: (As approved by the Owner)
 4. Hours for Core Drilling and Other noisy activity: (As approved by the Owner)
 5. Lifting, crane operations, and overhead work shall not occur while staff are in the facility.
- D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 1. Notify Owner not less than fourteen (14) days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- E. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 1. Notify Owner not less than fourteen (14) days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- F. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor air intakes.
- G. Controlled Substances: Use of tobacco products and other controlled substances within the existing building and on the Project site is not permitted.

- H. Employee Identification: Provide identification tags for Contractor personnel working on the Project site. Require personnel to utilize identification tags at all times. Contractor must provide required information to the Owner to allow proper background checks.
- I. Employee Screening: Comply with Owner's requirements regarding drug and background screening of Contractor personnel working on the Project site.
 - 1. Maintain list of approved screened personnel with Owner's Representative.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the 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.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

**SECTION 01 14 00
WORK RESTRICTIONS
TABLE OF CONTENTS**

PART 1 GENERAL

- 1.1 RELATED DOCUMENTS
- 1.2 USE OF PREMISES
- 1.3 OCCUPANCY REQUIREMENTS

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

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**SECTION 01 14 00
WORK RESTRICTIONS**

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 USE OF PREMISES

- A. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 - 1. Limits: Confine constructions operations to the specific areas indicated in the school.
 - 2. Owner Occupancy: Allow for Owner occupancy of site.
 - 3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.
- C. Background Checks: All workers who perform work on the site shall be subject to a full background check.
- D. Any crane/rigging work shall be completed when schools are unoccupied during weekends or days when students/faculty are not on site.
- E. Electrical shutdowns shall occur during weekends, holidays, and "off-hours" when the schools are not in use.
- F. Any work in "occupied" areas of the schools must take place during "off hours" when staff or students are not in spaces.
- G. COVID-19 Provisions: All workers who perform work on the site shall comply with CDC guidelines related to COVID-19 and all Caesar Rodney School District COVID-19 requirements.
- H. Contractor shall provide and install floor protection to prevent damage to the existing floors.

1.3 OCCUPANCY REQUIREMENTS

- A. Full Owner Occupancy: Owner will occupy site and existing building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

DIVISION 01 SECTION 012100
ALLOWANCES
TABLE OF CONTENTS

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- 1.2 SUMMARY
- 1.3 SELECTIONS AND PURCHASE
- 1.4 SUBMITTALS
- 1.5 COORDINATION
- 1.6 CONTINGENCY ALLOWANCES
- 1.7 ADJUSTMENT OF ALLOWANCES

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

- 3.1 EXAMINATION
- 3.2 PREPARATION
- 3.3 SCHEDULE OF ALLOWANCES

SECTION 012100 - ALLOWANCES

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 governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Unit-cost allowances.
 - 3. Quantity allowances.
 - 4. Contingency allowances.
 - 5. Testing and inspecting allowances.
- C. Related Sections:
 - 1. Division 01 Section "Unit Prices" for procedures for using unit prices.
 - 2. Division 01 Section "Quality Requirements" for procedures governing the use of allowances for testing and inspecting.
 - 3. Divisions 02 through 28 Sections for items of Work covered by allowances.

1.3 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

1.4 SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's overhead, profit, and related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.7 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. 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.
 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Contingency Allowance: Include a contingency allowance of Fifty Thousand Dollars (\$50,000.00) for use according to Owner's instructions.

END OF SECTION

DIVISION 01 SECTION 012300
ALTERNATES
TABLE OF CONTENTS

PART 1 GENERAL

- 1.1 RELATED DOCUMENTS
- 1.2 SUMMARY
- 1.3 DEFINITIONS
- 1.4 PRECEDURES

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

PART 4

- 4.1 SCHEDULE OF ALTERNATES

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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

- B. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

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

1.4 PROCEDURES

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

PART 4 - SCHEDULE OF ALTERNATES

4.1 SCHEDULE OF ALTERNATES

A. Alternate #1– Air Cooled Chiller #2 and Supporting Equipment

1. Base Bid: Do not provide or install the air cooled chiller #2 and its associated exterior piping, controls and electrical connections.
2. Alternate: Provide and install the new air cooled chiller #2 and its associated exterior piping, supports, bollards, controls, concrete pad, and electrical connections.

B. Alternate #2– ATC System by Modern Controls

1. Base Bid: Provide ATC Controls by any listed ATC vendor.
2. Alternate: Alternate: Provide additional costs, if any, for ATC system by Modern Controls as specified in specification section 230900 “Instrumentation and Controls of HVAC and Plumbing Systems.” If Modern Controls is the low cost ATC subcontractor, then the alternate value on the big form shall be listed as \$0.

C. Alternate #3 – Chiller Acoustical Discharge Plenum

1. Base Bid: Do not provide acoustical discharge plenum for chillers.
2. Alternate: Provide additional costs for acoustical discharge plenum for Chiller #1 \$_____ and Chiller #2 \$_____.

END OF SECTION 012300

**SECTION 01 25 00
SUBSTITUTION PROCEDURES
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- 1.1 RELATED DOCUMENTS
- 1.2 SUMMARY
- 1.3 DEFINITIONS
- 1.4 SUBMITTALS
- 1.5 QUALITY ASSURANCE
- 1.6 PROCEDURES

PART 2 PRODUCTS

- 2.1 SUBSTITUTIONS

PART 3 EXECUTION (Not Used)

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SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Sections:
 - 1. Division 01 Section 01 23 00 "Alternates" for products selected under an alternate.
 - 2. Division 01 Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 3. Divisions 02 through 28 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 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 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. 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 engineers, 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.
 - 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. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer 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 Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer 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 qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Modify 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 upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer 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

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SUBSTITUTION REQUEST (After the Bidding Phase)

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

A/E Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
Manufacturer: _____ Address: _____ Phone: _____
Trade Name: _____ Model No.: _____
Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached - REQUIRED BY A/E

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____
Address: _____ Owner: _____
_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitution: _____ (\$ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SUBSTITUTION REQUEST (Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

A/E's REVIEW AND ACTION

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01330.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01330.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: _____

Date: _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ _____

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES
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PART 2 PRODUCTS (Not Used)

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SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 60 00 "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Engineer 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: Engineer 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 Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within (7) seven days 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 additional 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 Engineer.
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 01 60 00 "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.
- C. The Proposal Request shall include the Allowable Overhead and Profit Mark-Up scheduled in the General Conditions.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, the Engineer will issue a Change Order for signatures of Owner, Contractor and Engineer.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Engineer 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

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**SECTION 01 29 00
PAYMENT PROCEDURES
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PART 1 GENERAL

- 1.1 RELATED DOCUMENTS
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- 1.3 DEFINITIONS
- 1.4 SCHEDULE OF VALUES
- 1.5 APPLICATIONS FOR PAYMENT

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Division 01 Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.
 - 3. Division 01 Section 01 33 00 "Submittal Procedures" for administrative requirements governing the preparation and submittal of submittal 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 Engineer at earliest possible date but no later than the Work Initiation Conference.
 - 3. Subschedules: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of 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 Engineer.
 - c. Engineer's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Submit draft of AIA Document G703 Continuation Sheets.
 3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 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. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.
10. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
11. 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 Engineer 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 and AIA Document G703 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. Engineer 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. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:

- a. Materials previously stored and included in previous Applications for Payment.
 - b. Work completed for this Application utilizing previously stored materials.
 - c. Additional materials stored with this Application.
 - d. Total materials remaining stored, including materials with this Application.
- F. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's 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 conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
- H. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
 1. List of subcontractors.
 2. Schedule of Values.
 3. Contractor's Construction Schedule (preliminary if not final).
 4. Products list.
 5. Submittals Schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. List of Contractor's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of preconstruction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.
- J. Application for Payment at Substantial Completion and in accordance with the applicable sections in the College's General Terms and Conditions: 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.
- K. Final Payment Application and in accordance with the applicable sections in the College's General Terms and Conditions: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707, "Consent of Surety to Final Payment."
 7. Evidence that claims have been settled.
 8. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

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SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION
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PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
1. General project coordination procedures.
 2. Administrative and supervisory personnel.
 3. Requests for Information (RFIs).
 4. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.
- C. Related Sections include the following:
1. Division 01 Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule (Accepted Baseline and Monthly Updates).
 2. Division 01 Section 01 73 00 "Execution Requirements" for procedures for coordinating general installation and field-engineering services.
 3. Division 01 Section 01 77 00 "Closeout Procedures" for coordinating Contract closeout.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Engineer, or Contractor seeking information from each other during construction.

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 to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum 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.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule (Accepted Baseline and Monthly Updates).
 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. Pre-installation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 KEY PERSONNEL

- A. 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, office, and cellular telephone numbers and email addresses. 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 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor 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 information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Engineer.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: CSI Form 13.2A.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for 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 Engineer's actions on submittals.
 - f. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
3. Engineer'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 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.
- E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer 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 weekly. Use CSI Log Form 13.2B. Include the following:
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Engineer.
 4. RFI number including RFIs that were dropped and not submitted.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Engineer's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

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 Engineer of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. 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. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of record documents.
 - m. Use of the premises and existing building.
 - n. Work restrictions.
 - o. Working hours.
 - p. Owner's occupancy requirements.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for moisture and mold control.
 - s. Procedures for disruptions and shutdowns.
 - t. Construction waste management and recycling.
 - u. Parking availability.
 - v. Office, work, and storage areas.
 - w. Equipment deliveries and priorities.
 - x. First aid.
 - y. Security.
 - z. Progress cleaning.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity 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 Engineer of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility 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 other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a Project closeout conference, at a time convenient to Owner and Engineer, but no later than 30 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

- a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing sustainable design documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.

- 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) 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) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.8 SUBMITTALS

A. Contractor Deliverables:

B. Monthly Progress Report Deliverables: Prepare and submit Monthly Deliverables as described below:

1. Project Narrative providing executive summary, any schedule deviations, and current issues.
2. Update Schedule providing status of individual Activity Time and Cost Progress projected to end of month.
3. Safety Log providing to-date summary lists of incidents or illnesses.
4. Submittal Log.
5. RFI Log.
6. Change Order Log.
7. Quality Assurance/Quality Control Log, with summary statement.

C. Coordination Drawings: Prepare Coordination Drawings.

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 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 Engineer 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 (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
3. Number of Copies: Submit two opaque copies of each submittal. Engineer will return one copy.
 - a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Engineer will retain two copies; remainder will be returned.
4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

- D. Key Personnel Names: Within 15 days of receiving Notice To Proceed, 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.

1.9 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.
1. Include special personnel required for coordination of operations with other contractors.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION
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SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Baseline Construction Schedule.
 - 2. Update 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 01 29 00 "Payment Procedures" for submitting the Schedule of Values.
 - 2. Division 01 Section 01 31 00 "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
 - 3. Division 01 Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
 - 4. Division 01 Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

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

- B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Engineer.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Days: Unit of time duration in calendar days, unless specifically indicated to be work days.
- F. Event: The starting or ending point of an activity.
- G. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time belongs to Owner.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- H. Fragment: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- I. Major Area: A story of construction, a separate building, or a similar significant construction element.
- J. Milestone: A key or critical point in time for reference or measurement.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
- B. Start-up construction schedule.
 - 1. Approval of cost-loaded start-up construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource

loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
- E. Field Condition Reports: Submit at time of discovery of differing conditions.
- F. Special Reports: Submit at time of unusual event.
- G. Qualification Data: For scheduling consultant.

1.5 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 Engineer's final release or approval.
- B. Baseline Construction Schedule: Submit two opaque copies.
1. Approval of cost-loaded Baseline Construction Schedule will not constitute approval of Schedule of Values for cost-loaded activities.
- C. Update Construction Schedule: Submit two opaque copies of Update Construction Schedule, large enough to show entire schedule for entire construction period.
1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- 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.

1.6 QUALITY ASSURANCE

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

- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Review delivery dates for Owner-furnished products.
 4. Review schedule for work of Owner's separate contracts.
 5. Review time required for review of submittals and resubmittals.
 6. Review requirements for tests and inspections by independent testing and inspecting agencies.
 7. Review time required for completion and startup procedures.
 8. Review and finalize list of construction activities to be included in schedule.
 9. Review submittal requirements and procedures.
 10. Review procedures for updating schedule.

1.7 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 Baseline and Update Construction Schedules 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 Baseline and Update 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 Baseline Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Baseline Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."
- B. Contractor's Construction Schedule Acceptance is represented in two forms: 1) Accepted Baseline Schedule, and 2) Accepted Monthly Update Schedule.
- C. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial 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.
- D. 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 30 days, unless specifically allowed by Engineer.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 30 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. Airflow Monitoring Stations
 - b. Electrical Gear
 - c. ATC Controls
 - d. Structural Supports
 - e. Single Zone VAV Units
 - f. ERV Units
 - g. Fan Coils
 - h. Chillers
 - i. Boilers
 - j. Pumps and Accessories
 - k. Ceilings
 3. Submittal Review Time: Include review and re-submittal times indicated in Division 01 Section 01 33 00 "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 14 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Completion: Include not more than 30 days for punch list and final completion.

- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. 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.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
 6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Refurbishment Completion.
 - b. Permanent space enclosure.
 - c. Completion of mechanical installation.
 - d. Completion of ductwork.
 - e. Completion of electrical installation.
 - f. Completion of testing/balancing.
 - g. Substantial Completion.
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Equipment Deliveries Complete, Equipment in Place, Systems Ready for Test, Substantial Completion, and Final Completion

- G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragments to demonstrate the effect of the proposed change on the overall project schedule.
- H. 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 01 29 00 "Payment Procedures" for cost reporting and payment procedures.
- I. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered RFIs.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
- J. Recovery Schedule: When periodic update indicates the Work is fourteen (14) or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- K. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
 - 1. Utilize Microsoft Project, Primavera, or Prolog, for Windows XP operating system.

2.3 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. Emergency procedures.
 - 12. Orders and requests of authorities having jurisdiction.
 - 13. Change Orders received and implemented.
 - 14. Construction Change Directives received and implemented.
 - 15. Services connected and disconnected.

16. Equipment or system tests and startups.
 17. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- 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 on CSI Form 13.2A. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

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 Engineer, 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

**SECTION 01 33 00
SUBMITTAL PROCEDURES
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- 3.1 CONTRACTOR'S REVIEW

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the Schedule of Values.
 - 2. Division 01 Section 01 31 00 "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
 - 3. Division 01 Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule.
 - 4. Division 01 Section 01 77 00 "Closeout Procedures" for submitting warranties.
 - 5. Division 01 Section 01 78 39 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 6. Division 01 Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 7. Division 01 Section 01 79 00 "Demonstration and Training" for training of Owner's personnel.
 - 8. Divisions 02 through 26 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.
- 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.

1.4 SUBMITTAL PROCEDURES

- A. General: Electronic copies of CAD Drawings of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals at the cost identified in Paragraph 1.5.
- 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. 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. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Submittals Schedule: Comply with requirements in Division 01 Section 01 32 00 "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 - 4. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer and to Engineer's consultants, allow 15 days for review of each submittal. Submittal will be returned to Engineer before being returned to Contractor.
- E. Identification: Place a permanent label or title block on each submittal 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 Engineer.
 - 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.

- c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address 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 decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
 - 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.
- F. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- G. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
 - 2. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.
- H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.
- 1. Transmittal Form: Use CSI Form 12.1A found in Section 00 62 11 "Submittal Transmittal Form".
 - 2. 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. Drawing number and detail references, as appropriate.
 - j. Transmittal number.
 - k. Submittal and transmittal distribution record.
 - l. Remarks.
 - m. Signature of transmitter.

3. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.
- I. 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 "Approved" or "Approved as Noted."
 4. 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.
 - J. 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.
 - K. Use for Construction: Use only final submittals with mark indicating "Approved" taken by Engineer
- 1.5 CONTRACTOR'S USE OF ENGINEER'S CAD FILES
- A. General: At Contractor's written request, copies of Engineer's CAD files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:
 - B. General: Electronic copies of CAD Drawings of the Contract Drawings may be provided by Engineer for Contractor's use in preparing submittals.
 1. The Documents for this project were prepared using commercial software on computers.
 2. Drawing files (in AutoCAD V2018) are available to the Contractor.
 3. These digital files will only be released with original signature on the "Digital Information Electronic Release Agreement Form found in Section 00 62 90 "CAD File Release".

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
 1. Submit electronic submittals via email as PDF electronic files.
 - a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

- 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 printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Standard product operation and maintenance manuals.
 - j. Compliance with specified referenced standards.
 - k. Testing by recognized testing agency.
 - l. Application of testing agency labels and seals.
 - m. Notation of coordination requirements.
 4. Submit Product Data before or concurrent with Samples.
 5. Number of Copies: Submit one PDF electronic file. Engineer will return one electronic copy with comment page. Mark up and retain one returned copy as a Project Record Document.
- 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 of Engineer's CAD Drawings are otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 - m. Relationship to adjoining construction clearly indicated.
 - n. Seal and signature of professional engineer if specified.
 - o. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

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 40 inches (750 by 1000 mm).
 3. Number of Copies: Submit two opaque (bond) copies of each submittal. Engineer will return one copy.
 4. Number of Copies: Submit three opaque copies of each submittal, unless copies are required for operation and maintenance manuals. Submit five copies where copies are required for operation and maintenance manuals. Engineer will retain two copies; remainder will be returned.
 5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- D. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section 01 32 00 "Construction Progress Documentation" for Construction Manager's action.
- E. Submittals Schedule: Comply with requirements specified in Division 01 Section 01 32 00 "Construction Progress Documentation."
- F. Application for Payment: Comply with requirements specified in Division 01 Section 01 29 00 "Payment Procedures."
- G. Schedule of Values: Comply with requirements specified in Division 01 Section 01 29 00 "Payment Procedures."
- H. 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. 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. Number of Copies: Submit three copies of subcontractor list, unless otherwise indicated. Engineer will return two copies.
 - a. Mark up and retain one returned copy as a Project Record Document.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.

1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Engineer will not return copies.
 2. Certificates and Certifications: Provide a notarized 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.
 3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section 01 40 00 "Quality Requirements."
- B. Coordination Drawings: Comply with requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section 01 32 00 "Construction Progress Documentation."
- D. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section 01 40 00 "Quality Requirements."
- E. Preconstruction Test Reports: Prepare 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.
- F. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, 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.
- G. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section 01 78 23 "Operation and Maintenance Data."
- H. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates.
 2. Required substrate tolerances.
 3. Sequence of installation or erection.
 4. Required installation tolerances.
 5. Required adjustments.
 6. Recommendations for cleaning and protection.
- I. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.

4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- J. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- K. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Engineer.
1. Engineer will not review submittals that include MSDSs and will return the entire submittal for resubmittal.
- L. Coordination Drawings: Comply with requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination."
- M. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of engineers and owners, and other information specified.
- N. 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.
- O. 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.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. 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.
- S. 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.
- T. 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.
- U. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section 01 40 00 "Quality Requirements."
- V. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- W. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- X. Field Test Reports: Submit 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.
- Y. Maintenance Data: Comply with requirements specified in Division 01 Section 01 78 23 "Operation and Maintenance Data."
- Z. 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. 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 Engineer.
- B. 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 ENGINEER'S / ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. Reviewed: Approved.
 - 2. Reviewed: Submittals which require no corrections.
 - 3. Rejected: Not Approved. Constricting to requirement of the Contract Documents. Do not perform work illustrated.
 - 4. Resubmit as specified: Item required major correction, future clarification and/or completion. Do not perform work illustrated.
 - 5. For Information only/Not Reviewed: Submittals that are not required by Contract Documents to be reviewed by Engineer.
 - 6. Comments Noted: Make corrections noted.
 - 7. Revise & Resubmit: To be corrected and returned for approval. Do not perform work as illustrated.
 - 8. Resubmit for Record Only: Proceed with work and re-submit information submitted for Engineers records.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS
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SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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 quality-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 Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
 - 1. Division 01 Section 01 32 00 "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 2. Divisions 02 through 28 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 Engineer.

- C. Preconstruction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- D. 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 specified requirements.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.
- I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: 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 conflicting requirements that are different, but apparently equal, to Engineer 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 Engineer for a decision before proceeding.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For ductwork, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Contractor's Quality-Control Manager Qualifications: For supervisory personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems.
 1. Seismic-force resisting system, designated seismic system, or component listed in the designated seismic system quality assurance plan prepared by the Engineer.
 2. Main wind-force resisting system or a wind-resisting component listed in the wind-force-resisting system quality assurance plan prepared by the Engineer.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 1. Specification Section number and title.
 2. Entity responsible for performing tests and inspections.
 3. Description of test and inspection.
 4. Identification of applicable standards.
 5. Identification of test and inspection methods.
 6. Number of tests and inspections required.
 7. Time schedule or time span for tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality-control service.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.

10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspection.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representatives making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
- 1.8 QUALITY ASSURANCE
- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. 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 329; 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. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.

- e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups; 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 Engineer, 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.

1.9 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. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
 3. Costs for retesting and reinspection construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. 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.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section 01 33 00 "Submittal Procedures."

- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspection: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspection, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

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 Engineer.
 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 Engineer'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 or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section 01 73 00 "Execution Requirements."
- 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

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS
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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 11 00 "Summary" for limitations on utility interruptions and other work restrictions.
 - 2. Division 01 Section 01 33 00 "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
 - 3. Division 01 Section 01 73 00 "Execution Requirements" for progress cleaning requirements.
 - 4. Divisions 02 through 26 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.

1.3 USE CHARGES

- A. General: Utility usage shall not be metered. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Engineer, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Owner will pay sewer service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Owner will pay water service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Utility usage shall not be metered. Provide connections and extensions of services as required for construction operations.
- E. Water and Sewer Service from Existing System: 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.

- F. Electric Power Service from Existing System: Electric power from Owner's existing 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, staging areas, crane mobilization area, and parking areas for construction personnel.
- B. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage, including delivery, handling, and storage provisions for materials subject to water absorption or water damage, discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged Work.

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 TEMPORARY FACILITIES

- A. Field Offices, General: Space within building shall be utilized as field offices.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

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 01 11 00 "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.
 - 1. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities. Owner will not allow use of onsite sanitary facilities.
- D. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.
- E. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- D. 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 temporary, directional signs for construction personnel and visitors.
 2. Maintain and touchup signs so they are legible at all times.
- E. 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.
- F. 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.
- G. 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 01 73 00 "Execution Requirements" for progress cleaning requirements.
- H. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
- 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 01 11 00 "Summary of Work."
- B. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
 1. Construct covered walkways using scaffold or shoring framing.
 2. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 3. Paint and maintain appearance of walkway for duration of the Work.
- D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
- E. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

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, 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 01 77 00 "Closeout Procedures."

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS
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SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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 01 77 00 "Closeout Procedures" for submitting warranties for Contract closeout.
 - 2. Division 01 Section 01 23 00 "Alternates" for products selected under an alternate.
 - 3. Division 01 Section 01 25 00 "Substitution Procedures" for requests for substitutions.
 - 4. Divisions 02 through 26 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. Products salvaged or recycled from other projects are not considered new products.
 - 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. 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 first named product, 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. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
 2. Form: Tabulate information for each product under the following column headings:
 - a. Specification Section number and title.
 - b. Generic name used in the Contract Documents.
 - c. Proprietary name, model number, and similar designations.
 - d. Manufacturer's name and address.
 - e. Supplier's name and address.
 - f. Installer's name and address.
 - g. Projected delivery date or time span of delivery period.
 - h. Identification of items that require early submittal approval for scheduled delivery date.
 3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 - a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
 4. Completed List: Within 60 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 5. Engineer's Action: Engineer will respond in writing to Contractor within 15 days of receipt of completed product list. Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement to comply with the Contract Documents.
- B. 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 found in Section 00 63 25.
 2. 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 Engineers 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.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Engineer 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 Engineer cannot make a decision on use of a proposed substitution within time allocated.
- C. Comparable Product 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. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer 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: As specified in Division 01 Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Engineer cannot make a decision on use of a comparable product request within time allocated.
- D. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section 01 33 00 "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. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

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.

8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: 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. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
 3. Refer to Divisions 02 through 26 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section 01 77 00 "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," Engineer will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Engineer'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. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed 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 Engineer's sample. Engineer'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, Engineer 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, Engineer 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: Engineer will consider requests for substitution if received within 15 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer 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 Engineer 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.
 - 10. 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.

2.3 COMPARABLE PRODUCTS

- A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer 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 Engineers and owners, if requested.

5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION

**SECTION 01 73 00
EXECUTION
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SECTION 01 73 00
EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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 01 31 00 "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 2. Division 01 Section 01 33 00 "Submittal Procedures" for submitting surveys.
 - 3. Division 01 Section 01 73 29 "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
 - 4. Division 01 Section 01 77 00 "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 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate how long services and systems will be disrupted.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from the Engineer before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Mechanical systems piping and ducts.
 - f. Control systems.
 - g. Communication systems.
 - h. Conveying systems.
 - i. Electrical wiring systems.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or

decreased operational life or safety. Other construction elements include but are not limited to the following:

- a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Equipment supports.
 - d. Piping, ductwork, vessels, and equipment.
 - e. Noise- and vibration-control elements and systems.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

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

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 invert elevation at points of connection of underground electrical services and other utilities.
- B. 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. 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.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. 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 Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Interpretation", form enclosed in Division 01 Section 01 32 00 "Construction Progress Documentation."

- D. Surface and Substrate Preparation: Comply with manufacturer's recommendations for preparation of substrates to receive subsequent work.

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until 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 Engineer.
 2. Allow for piping, 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.

3.4 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Temporary Support: Provide temporary support of work to be cut.
- C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- E. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

- a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- F. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 OWNER-INSTALLED PRODUCTS

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

3.6 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 (27 deg C).
 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.

- 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. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- F. 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.
- G. 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.
- H. 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.
- I. 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.

3.7 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 01 40 00 "Quality Requirements."

3.8 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.

3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section 01 73 29 "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

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CUTTING AND PATCHING
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SECTION 01 73 29
CUTTING AND PATCHING

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 procedural requirements for cutting and patching.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 73 20 "Selective Demolition" for demolition of selected portions.
 - 2. Divisions 02 through 28 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
 - 3. Division 07 Section 07 84 13 "Penetration Firestopping" for patching fire-rated construction.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.

6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
 1. Primary operational systems and equipment.
 2. Air or smoke barriers.
 3. Fire-suppression systems.
 4. Mechanical systems piping and ducts.
 5. Control systems.
 6. Communication systems.
 7. Electrical wiring systems.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
 1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Exterior curtain-wall construction.
 4. Equipment supports.
 5. Piping, ductwork, vessels, and equipment.
 6. Noise- and vibration-control elements and systems.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance.
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 - 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance. Where ceiling tiles are removed and are damaged, the

- same shall be replaced with new ceiling tiles to match existing. Where ceiling grid is damaged replace with new ceiling grid to match existing.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
 6. Patch and repair masonry work to match exiting adjacent construction.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

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**SECTION 01 77 00
CLOSE-OUT PROCEDURES
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**SECTION 01 77 00
CLOSEOUT PROCEDURES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
 2. Substantial Completion procedures.
 3. Final completion procedures.
 4. Warranties.
 5. Final cleaning.
- B. Related Sections include the following:
1. Division 01 Section 01 29 00 "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
 2. Division 01 Section 01 73 00 "Execution" for progress cleaning of Project site.
 3. Division 01 Section 01 78 39 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 4. Division 01 Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 5. Division 01 Section 01 79 00 "Demonstration and Training" for requirements for instructing Owner's personnel.
 6. Divisions 02 through 26 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, 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, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer 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 Engineer, 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 01 29 00 "Payment Procedures."
2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. 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. Submit demonstration and training videotapes.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements.

Engineer 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, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Page number.

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer 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 (215-by-280-mm) paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "MAGNOLIA MIDDLE SCHOOL HVAC RENOVATIONS," Project name, and name of Contractor.
 4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
- 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 for final cleaning. 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 other required labels and identification, 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 operating conditions during construction that may impede operation or reduce longevity.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts and HVAC units if units were operated without filters during construction or that display contamination with particulate matter upon inspection.
 - q. 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.
 - r. Leave Project clean and ready for occupancy.
- C. 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.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section 01 50 00 "Temporary Facilities and Controls."

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OPERATION AND MAINTENANCE DATA
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PART 3 EXECUTION

- 3.1 MANUAL PREPARATION

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SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Maintenance manuals for the care and maintenance of systems and equipment.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Division 01 Section 01 77 00 "Closeout Procedures" for submitting operation and maintenance manuals.
 - 3. Division 01 Section 01 78 39 "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
 - 4. Divisions 02 through 26 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. Engineer will return both 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. Engineer will return copy with comments within 15 days after final inspection.

1. Correct or modify each manual to comply with Engineer's comments. Submit three (3) copies of each corrected manual within 15 days of receipt of Engineer's comments and one (1) copy electronically.

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 equipment.
 3. 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 Engineer.
 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 (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "CAESAR RODNEY SCHOOL DISTRICT – MAGNOLIA MIDDLE SCHOOL – HVAC RENOVATIONS - OPERATION AND MAINTENANCE MANUAL" 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. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

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.

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.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings in Division 01 Section 01 78 39 "Project Record Documents."
- G. Comply with Division 01 Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION

SECTION 01 78 39
PROJECT RECORD DOCUMENTS
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- 1.1 RELATED DOCUMENTS
- 1.2 SUMMARY
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 RECORD DRAWINGS
- 2.2 RECORD SPECIFICATIONS
- 2.3 RECORD PRODUCT DATA
- 2.4 MISCELLANEOUS RECORD SUBMITTALS

PART 3 EXECUTION

- 3.1 RECORDING AND MAINTENANCE

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 73 00 "Execution Requirements" for final property survey.
 - 2. Division 01 Section 01 77 00 "Closeout Procedures" for general closeout procedures.
 - 3. Division 01 Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 4. Divisions 02 through 28 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(s) of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or 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. Revisions to routing of piping and conduits.
 - d. Revisions to electrical circuitry.
 - e. Actual equipment locations.
 - f. Locations of concealed internal utilities.
 - g. Changes made by Change Order or Construction Change Directive.
 - h. Changes made following Engineer's written orders.
 - i. Details not on the original Contract Drawings.
 - j. Field records for variable and concealed conditions.
 - k. 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. Record Transparencies: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Engineer. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.
1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.
 2. Refer instances of uncertainty to Engineer for resolution.

3. Owner will furnish Contractor one set of transparencies of the Contract Drawings for use in recording information.
 4. Print the Contract Drawings and Shop Drawings for use as Record Transparencies. Engineer will make the Contract Drawings available to Contractor's print shop.
- C. Format: Identify and date each Record Drawing; include the designation "Caesar Rodney School District – Magnolia Middle School – HVAC Renovations - 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. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.
 3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "Caesar Rodney School District – Magnolia Middle School – HVAC Renovations - PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - 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, Record Product Data, and Record Drawings where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

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 Engineer's reference during normal working hours.

END OF SECTION

**SECTION 01 79 00
DEMONSTRATION AND TRAINING
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- 1.4 CLOSE OUT SUBMITTALS
- 1.5 QUALITY ASSRANCE
- 1.6 COORDINATION

PART 2 PRODUCTS

- 2.1 INSTRUCTION PROGRAM

PART 3 EXECUTION

- 3.1 PREPARATION
- 3.2 INSTRUCTION

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SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 31 00 "Project Management and Coordination" for requirements for preinstruction conferences.
 - 2. Divisions 02 through 26 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name of Engineer.
 - c. Name of Contractor.
 - d. Date of video recording.
 - 2. Transcript: Prepared on 8-1/2-by-11-inch (215-by-280-mm) paper, punched and bound in heavy-duty, three-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
 - 3. At completion of training, submit complete training manual(s) for Owner's use.

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 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - 1. Electrical components
 - 2. HVAC units
 - 3. ATC System
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Operations manuals.
 - b. Maintenance manuals.
 - c. Project Record Documents.
 - d. Identification systems.
 - e. Warranties and bonds.
 - f. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:

- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual organized in coordination with requirements in Division 01 Section 01 78 23 "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. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Engineer, 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

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DIVISION 01 SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS
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SECTION 01 91 13 – 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 26 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.
- D. 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.

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. Punch Lists.
 8. Test/Balance Reports.
 9. Listing of off-season test(s) not performed and a schedule for their completion.
 10. 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."

HVAC RENOVATIONS
SRS2503

CAESAR RODNEY SCHOOL DISTRICT
MAGNOLIA MIDDLE SCHOOL

END OF SECTION

DIVISION 01 SECTION 01 91 14
PLUMBING COMMISSIONING REQUIREMENTS
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SECTION 01 91 14 – 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. Backflow preventers.
 - 2. Condensate Neutralizers.
 - 3. Domestic water meter (including interlock to ATC system).
 - 4. Gas Pressure Regulators.
 - 5. Makeup Water Meters. (Mechanical and ATC Type)
 - 6. Pressure Reducing 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.
4. Assist testing flow rates of all plumbing fixtures and plumbing equipment.

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 balancing valves to allow proper balancing and recording of water flow.
 - iii. 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.
 - iv. Flow rates and aerations 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 and equipment.
 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 life-safety systems during each mode of operation.
 9. Annotate checklist or data sheet when a deficiency is observed.
 10. Verify equipment interface with TAB criteria; include the following:
 - a. Backflow preventer cross connection tests.
 - b. Domestic water meter total volume in gallons.
 - c. Water meter flow rates and calibration.
 - d. Gas pressure regulator.
 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 the operation and flow rates of all plumbing equipment.
- 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. Life-safety and safety systems.
 3. Temporary upset of system operation.
 4. Partial occupancy conditions.
 5. Special cycles.

6. Alarm conditions.
7. Lead/lag operation where redundant equipment is indicated.
8. 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. Verify that all backflow preventers have been tested. Document in writing.
 4. Test operation of all water meters.
 5. Test water meters and interlock with ATC system.
 6. Verify that backflow preventers have been tested.
 7. Test makeup water valve train flow meter.
 8. Verify PRV/gas pressure regulator setpoints.
- 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 backflow preventers and domestic water meters. 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 section 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.

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SECTION 01 91 15 - 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. Air Separators.
 - 3. Automatic Glycol Feeders.
 - 4. Automatic Temperature Control System.
 - 5. Boiler alarms.
 - 6. Boilers and burners.
 - 7. Carbon Monoxide Detector.
 - 8. Carbon Dioxide Sensors.
 - 9. Combustion air damper interlock to existing water heater.
 - 10. Chilled water system.
 - 11. Chiller alarms.
 - 12. Condensate overflow alarms.
 - 13. Condensate pumps.
 - 14. Dampers.
 - 15. Dewpoint temperature sensors.

16. Differential Pressure Bypass Valves.
17. Differential Static Pressure Controllers.
18. Duct smoke detectors.
19. Electric Radiant Heat Panels.
20. Electric heat tracing.
21. Energy recovery ventilators (Including variable frequency drives).
22. Expansion tanks.
23. Exhaust Fans and ventilation fans.
24. Fan coil units.
25. Flame Failure Alarms.
26. Flow measuring stations.
27. Flow Switches.
28. Heat Pipes.
29. High and low temperature alarms.
30. Hydronic Unit Heaters.
31. Hot water systems.
32. HVAC controls and sequences of operation.
33. Low Water Cut-Offs and Alarms.
34. Makeup water meter flow rates and alarms.
35. Minimum Flow Bypass Valves/Controls.
36. Pressure Independent Control Valves.
37. Pumps.
38. Pump VFD Alarms.
39. Relative Humidity Sensors.
40. Relief Air Dampers.
41. Single Zone VAV Units.

- 42. Static Pressure Sensors.
- 43. Temperature Sensors.
- 44. Unit Heaters.
- 45. Variable frequency drives.
- 46. Ventilation Fans.
- 47. 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. Automatic Glycol Feeder operation and ATC interlocks.
 - b. All pump status alarms, pump operation, flow rates, and controls.
 - c. All temperature alarms.
 - d. Boiler temperatures, flow rates, low water cut-off interlock, flame failure interlocks, flow switches, and amperage.
 - e. Building pressurization and room differential pressures.
 - f. Chiller flow rates, temperatures, set points, and safeties.
 - g. Differential bypass valves and transmitters.

- h. Duct Smoke detectors operation and interlocks with fire alarm system.
 - i. Electric heating equipment volts, amps, and temperature rise.
 - j. Electric Heat Tracing.
 - k. Electric Radiant Heat Panel Temperature Sensors.
 - l. Fan coil unit air/water flow rates and temperatures.
 - m. Head pressure controls for air-cooled chillers.
 - n. Heat pipe temperatures.
 - o. Hot water coils, airflow rates, pressure drops, temperatures, and fluid flow rate.
 - p. Hydronic unit heater temperature and flow rates.
 - q. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
 - r. Operation/Accuracy of air and fluid flow measuring stations at various flow rates.
 - s. Pump flow rates, pressure, VFD alarms, and amperage at each operating mode.
 - t. Sequences of operation of all HVAC equipment.
 - u. Set point and operation of high temperature alarms.
 - v. Supply and return air flow rates for all HVAC equipment.
 - w. Supply and return flow rates for VAV and constant volume systems in each operational mode.
 - x. Supply, outside air, exhaust and return air flow rates for SZVAV's and ERVs in each operating mode.
 - y. Test and calibrate all static pressure sensors.
 - z. Test all flow switches including operation and alarms.
 - aa. Test boiler low water cut-off, condensate block switches, flow switches, and flame failure alarms.
 - bb. Test operation and air temperatures of hot gas re-heat coils.
 - cc. Total exhaust airflow and total outdoor-air intake.
 - dd. Unit heaters operation and control.
 - ee. Variable speed drive parameters at each operated mode.
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/relief air damper operation.
5. Fluid flow rates, pressure, and temperatures for all hydronic equipment.
6. Life-safety and safety systems.
7. Duct detectors.
8. Fire safety.
9. Temporary upset of system operation.
10. Partial occupancy conditions.
11. Special cycles.
12. ERV/Single Zone VAV Unit supply/exhaust air flow at partial CO2 levels.
13. Lead/lag/standby modes of operation where redundant equipment is indicated.
14. All alarms.
15. Flow switch shut-down and alarm.
16. Condensate overflow safety switch shut-down and alarm.
17. Condensate pump operation.
18. Test operation and accuracy of air/fluid flow measuring stations and make-up water meters.

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, and auxiliary equipment, unit heaters, radiant heat panels, single zone VAV units, hydronic unit heaters, fan coil units, and boilers. 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.

- I. Refrigeration/Heat Rejection System Testing: HVAC Contractor shall prepare a testing plan to verify performance of chillers, refrigerant compressors, condensers, ductless units, condensing units, hot gas re-heat coils, heat pipes, fan coil units, and unit heaters 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.
- J. HVAC Distribution System Testing: HVAC Contractor shall prepare a testing plan to verify performance of air, air handling units, and hydronic distribution systems, special exhaust, ERV unit supply and exhaust, flow measuring stations, and single zone VAV units 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

**SECTION 024100
DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 003100 - Available Project Information: Existing building survey conducted by Owner; information about known hazardous materials.
- B. Section 011000 - Summary: Limitations on Contractor's use of site and premises.
- C. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- D. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary barriers and security devices.
 - 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
- B. Do not begin removal until receipt of notification to proceed from Owner.

3.02 EXISTING UTILITIES

- A. Protect existing utilities to remain from damage.
- B. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- D. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- E. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.03 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.

2. Report discrepancies to Architect before disturbing existing installation.
 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 - C. Remove existing work as indicated and as required to accomplish new work.
 - D. Protect existing work to remain.
 1. Repair adjacent construction and finishes damaged during removal work.
- 3.04 DEBRIS AND WASTE REMOVAL
- A. Remove debris, junk, and trash from site.
 - B. Leave site in clean condition, ready for subsequent work.
 - C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

SECTION 02 41 19
SELECTIVE DEMOLITION
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SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of selected site elements.
 - 3. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 11 00 "Summary of Work" for use of premises and Owner-occupancy requirements.
 - 2. Division 01 Section 01 50 00 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
 - 3. Division 01 Section 01 73 29 "Cutting and Patching" for cutting and patching procedures.

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. Items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove each item or object in a manner to prevent damage and deliver promptly to Owner.

1.5 SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of proposed dust- and noise-control temporary partitions and means of egress.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 - 7. Means of protection for items to remain and items in path of waste removal from building.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- D. Predemolition Videotapes: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.
- E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

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. Refrigerant Recovery Technician Qualifications: Certified by an EPA – approved certification program.
- E. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review 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. Owner will occupy portions of building and site immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
 1. Comply with requirements specified in Division 01 Section 01 11 00 "Summary of Work."
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition. Video tape all existing areas prior to selective demolition work.
- D. 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 Engineer and Owner. Owner will remove hazardous materials under a separate contract.
- E. Hazardous Materials: Hazardous materials are present in construction to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
- F. Storage or sale of removed items or materials on-site is not permitted.
- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain existing site 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.

PART 2 - PRODUCTS (Not Used)

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 Engineer.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction digital videotapes.
 - 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.

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 01 11 00 "Summary of Work."
- 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. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. 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. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Comply with requirements for access and protection specified in Division 01 Section 01 50 00 "Temporary Facilities and Controls."
- B. 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 specified in Division 01 Section 01 50 00 "Temporary Facilities and Controls."
- C. 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 on-campus.
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 Engineer, 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.

E. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.5 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.

- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

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SECTION 042000
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete block.
- B. Split-face concrete block.
- C. Mortar and grout.
- D. Reinforcement and anchorage.
- E. Lintels.
- F. Accessories.

1.02 RELATED REQUIREMENTS

- A. Division 1 - Administrative Requirements: Preconstruction meeting.
- B. Section 076200 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
- C. Section 079200 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

- A. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2016.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.
- D. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units; 2014.
- E. ASTM C140/C140M - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2014.
- F. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2011.
- G. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- H. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006 (Reapproved 2011).
- I. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2014a.
- J. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2011.
- K. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2012.
- L. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2010.
- M. ASTM C1072 - Standard Test Method for Measurement of Masonry Flexural Bond Strength; 2013.
- N. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2014.
- O. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry; 2014.
- P. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2005.
- Q. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls; 2017.
- R. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2016.
- S. UL (FRD) - Fire Resistance Directory; current edition.

HVAC RENOVATIONS	CAESAR RODNEY SCHOOL DISTRICT
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1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting two weeks before starting work of this section; require attendance by all relevant installers.
- B. Refer to Section 01 3000 - Administrative Requirements for additional information.

1.05 SUBMITTALS

- A. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, masonry accessories, and cleaning products including application .
- B. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, and accessories for special shapes.
- C. Samples: Submit two samples of decorative block and facing brick units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements, including referenced material standards and fire ratings.
- E. Shop Drawings: Provide shop drawings of vertical wall reinforcement and bond beam reinforcement. Submit, with copies to the Owner's Independent Testing and Inspection Agency, shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Show details of construction, including dimensioned drawings, plans, elevations, sections, and details of components to be incorporated into Work including, but not limited to, the following:
 1. Flashing System: Large-scale details for each element of flashing system showing layout, profiles, methods of joining, and anchorage details; including lintel units, shelf units, corner units, end dam units, drip edges, conditions showing interface and relationship to adjacent materials, and other special applications.
 2. Fabricated Flashing: Detail corner units, end-dam units, drip edges, and other special applications.
 3. Anchors, Ties, and Accessories: Show sizes, coursing, and locations.
 4. Reinforcing: For masonry reinforcing bars; comply with ACI 315, "Details and Detailing of Concrete Reinforcement" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement. Show elevations of reinforced walls.

1.06 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: For each type of masonry unit, cementitious materials, and accessories required. Include data on material properties material test reports substantiating compliance with requirements. For brick, include test report for efflorescence according to ASTM C 67.
 1. Provide test reports based on testing within previous two years.
- B. Material Certificates: Submit material certificates for the following, signed by manufacturer and Contractor. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
 1. Each type of masonry unit.
 2. Cementitious materials. Include brand, type, and name of manufacturer. Provide certifications from manufacturer that no admixtures have been added to cementitious materials.
 3. Grout mixes. Include description of type and proportions of ingredients.
 4. Each material and grade indicated for reinforcing bars.
 5. Each type and size of joint reinforcement.
 6. Each type and size of anchors, ties, and metal accessory.

GIPE ASSOCIATES, INC. (GAI)	UNIT MASONRY
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- C. Mix Designs: Submit material test reports for the Owner's Independent Testing and Inspection Agency, indicating and interpreting test results relative to compliance of the following proposed masonry materials with requirements.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content. Include description of type and proportions of mortar ingredients.
 - 2. Include test reports, according to ASTM C 1019 for grout mixes required to comply with compressive strength requirement. Include description of type and proportions of grout ingredients.
- D. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Pre-Faced Units: 50 of each type, size, and color combination.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: The unit masonry work to be by a single firm specializing in exterior wall masonry work, for a period of not less than 5 years, so that there will be undivided responsibility in this single firm for such work.
 - 1. The Installer must be experienced with work comparable to the work shown and specified and who has completed projects with a successful in-service performance for a period of not less than 5 years.
 - 2. The Installer shall engage experienced and qualified subcontractors to perform any part of the masonry work which he is not equipped or qualified to perform properly with his own forces.
- B. Standards: Comply with the applicable provisions and recommendations of the following standards below, where standards conflict, the more stringent shall apply, and where a conflict between any stated standard and a project specific requirement of the specifications arise, the more stringent provision shall prevail.
 - 1. National Concrete Masonry Association (NCMA): "TEK" Information Series.
 - 2. American Concrete Institute (ACI):
 - a. ACI 530/ASCE 5/TMS 402: "Building Code Requirements for Masonry Structures."
 - b. ACI 530.1/ASCE 6/TMS 602: "Specifications for Masonry Structures."
 - 3. Brick Industry Association (BIA) "Technical Notes on Brick Construction."
 - 4. Underwriters Laboratories, Inc. (UL) "Fire Resistance Ratings."
 - 5. American Society for Testing and Materials (ASTM) E 2266 "Standard Guide for Design and Construction of Low-Rise Frame Building Wall Systems to Resist Water Intrusion."
- C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, through one source from a single manufacturer for each product required.
- D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- E. Owner's Independent Testing and Inspection Agency: The Owner will engage a qualified independent testing and inspection agency to perform preconstruction testing indicated below for field quality control. Payment for these services will be made by Owner. Independent

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testing agency to coordinate submittal of "Special Inspections" testing documentation for State of Delaware (State) review and approval.

1. The Contractor is responsible for the expense of testing or inspection resulting as a consequence of the following:
 - a. Work not evidencing compliance with this specification.
 - b. Testing to verify the adequacy of work done without prior notice, improper supervision, or contrary to standard construction practice.
2. Contractor's Responsibilities:
 - a. Furnish labor required to facilitate testing.
 - b. Provide materials, samples and access to materials as required for testing.
 - c. Provide a complete set of shop and erection drawings, including revisions to previous Architect reviewed submittals.
3. Owner's Independent Testing and Inspection Agency's Duties:
 - a. The Owner's Independent Testing and Inspection Agency shall conduct the following tests and inspections, interpret them, evaluate the results for compliance with the specifications, and report the findings to the Architect, Owner, Contractor, and Local Building Authority, as their interests may appear.
 - 1) Inspection and testing shall be in accordance with ACI requirements for masonry (ACI 530 and ACI 503.1) for the following inspections:
 - (a) Observation, sampling and placing of masonry units used in all reinforced masonry construction.
 - (b) Inspection reports during reinforced masonry erection.
 - (c) Observations of reinforcement condition, size and placement for compliance with ACI 530.
 - (d) Ambient temperature during reinforced masonry erection.
 - (e) Inspection of reinforced masonry materials to verify compliance with ACI 530.1.
 - (f) Prism testing of masonry.
 - (g) Observation of proportioning, mixing, consistency of mortar and grout for compliance with ACI 530.1.
 - (h) Observation of application of mortar, grout and masonry units for compliance with ACI 530.1.
 - (i) Observation of installation of anchors for compliance with ACI 530.
 - b. Tests shall be conducted at the start of the job, using materials and mixes sampled at point of deposit.
 - c. Testing of Mortar: The Owner's Independent Testing Laboratory shall verify mix consistency by daily testing in accordance with ASTM C780. Test shall establish specific and overall performance characteristics of the mortar system. Test reports shall be submitted to the Owner / Architect for review under the provisions of the Division 01 section under "General Requirements".
 - d. Test of grout for reinforced masonry for compliance with ASTM C 476 requirements for the types specified and strength shown, conduct and report the following:
 - 1) Compressive strength (ASTM C 1019); lab cure and break at a time increment of one at 7 days, and two at 28 days; a minimum of 1 field test shall be made for each 5000 square feet of reinforced CMU wall. Make no less than 3 tests.
 - e. Preliminary Test of Concrete Masonry Design Strength: With sufficient time, and not less than 28 days prior to the start of reinforced masonry construction, test for the compressive concrete masonry design strength (f'_m) as specified. The value of f'_m shall be determined by tests of masonry assemblies (prisms) in accordance with ACI

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530.1. Not less than five prisms shall be taken as 8 inches for reinforced CMU.

- f. Field Tests of Concrete Masonry Design Strength: During construction, the value of the compressive concrete masonry design strength (f'_m) shall be verified by field tests in accordance with the ACI and ASTM standards. A minimum of one field test shall be made for every 5000 square feet of reinforced CMU wall. Not less than three prisms shall be made for each field test. The thickness of the prisms shall be taken as 8 inches for the reinforced CMU.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided. During cold weather stockpile aggregates so that it may be possible to heat them for use in mixing mortar in compliance with ACI recommendations for cold weather masonry practices.
- D. Deliver pre-blended dry mortar mix, if used for the project, in moisture-resistant containers designed for use with dispensing silos. Store pre-blended dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

1.09 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Prevent excess moisture from entering work in progress.
 1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
 2. Protect door and window frames and exposed metal flashings from damage.
- B. Stain Prevention: Prevent mortar and soil from staining the face of masonry to be left exposed. Immediately remove mortar and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use metal reinforcing or ties having loose rust or other coatings that will reduce or destroy bond. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6 and ACI 530/ASCE 5 and the following requirements:
 1. If air temperature falls below 40 deg F, mixing water shall be heated.
 2. If the air temperature falls between 20 deg F and 32 deg F inclusively, sand and water shall be heated.

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3. If the air temperature falls below 20 deg F, in addition to the requirements of the preceding sub-paragraph, masonry units shall be heated, and heated enclosures shall be used with a minimum temperature of 40 deg F.
4. Masonry shall be protected from freezing for 24 hours after laying.
- D. Hot-Weather Requirements: When ambient temperature exceeds 100 deg F (38 deg C), or 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h), do not spread mortar beds more than 48 inches (1200 mm) ahead of masonry. Set masonry units within one minute of spreading mortar. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.10 DEFINITIONS

- A. Exterior: Areas exposed to the elements and areas located in unconditioned spaces
- B. Interior: Areas located in conditioned spaces

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 1. Size: Standard units with nominal face dimensions of 16 by 8 inches (400 by 200 mm) and nominal depths as indicated on drawings for specific locations.
 2. Special Shapes: Provide non-standard blocks configured for corners, lintels, jambs, sash, and other detailed conditions.
 3. Load-Bearing Units: ASTM C90, lightweight.
 - a. Hollow block, as indicated.
- B. Decorative Concrete Masonry Units
 1. Split Face Block: ASTM C 90:
 - a. Size:
 - 1) Size: Standard units with nominal face dimensions of 16 x 8 inches (400 x 200 mm) and nominal depths as indicated on the drawings for specific locations.
 - b. Pattern and Texture:
 - 1) Pattern: split face finish; ground face units sealed.
 - c. Color: match existing.
 2. Shapes: Provide special shapes indicated, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated. Special shapes include but are not limited to:
 - a. Corner units
 3. Manufacturers:
 - a. Basis of Design Split Face Product: York Building Products, Split Face: www.yorkbuilding.com.
 - 1) Subject to compliance with requirements, products by the following manufacturers are also acceptable:
 - (a) Nitterhouse Masonry Products, Architectural Masonry Split Face: www.nitterhousemasonry.com.
 - (b) Echelon Split Face: www.echelonmasonry.com.
 - (c) Fizzano Brothers; Split Face: www.fizzano.com
 - (d) Westbrook Concrete Block Co., Inc.: www.westbrookblock.com
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Units with Integral Water Repellent: Provide exterior concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at the time of manufacture.

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1. Performance of Units with Integral Water Repellent:
 - a. Water Permeance: When tested per ASTM E514/E514M and for a minimum of 72 hours.
 - 1) No water visible on back of wall above flashing at the end of 24 hours.
 - 2) No flow of water from flashing equal to or greater than 0.032 gallons per hour (0.05 L per hour) at the end of 24 hours.
 - 3) No more than 25 percent of wall area above flashing visibly damp at end of test.
 - b. Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
 - c. Compressive Strength: ASTM C1314; maximum 5 percent decrease.
2. Use only in combination with mortar that also has integral water repellent admixture.
3. Use water repellent admixtures for masonry units and mortar by a single manufacturer.

2.02 MORTAR AND GROUT MATERIALS

- A. Masonry Cement: not permitted.
- B. Portland Cement: ASTM C150/C150M, Type I or Type II, without air entrainment.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Mortar Aggregate: ASTM C144: sand.
- E. Grout Aggregate: ASTM C404.
- F. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
 1. Color(s): As selected by Architect from manufacturer's full range.
 - a. Basis of Design mortar color: Work-Rite WR-2062 Smoke.
- G. Water: Clean and potable.
- H. Accelerating Admixture: Not permitted.
- I. Integral Water Repellent Admixture for Mortar: Polymeric liquid admixture added to mortar at the time of manufacture.
 1. Use only in combination with concrete masonry units manufactured with integral water repellent admixture.
 2. Use only water repellent admixture for mortar from the same manufacturer as water repellent admixture in masonry units.
 3. Meet or exceed performance specified for water repellent admixture used in masonry units.
 - a. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - b. Master Builders, Inc.; Rheopel
 - c. Amerimix, an Oldcastle brand; AMX 410: www.amerimix.com.

2.03 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers:
 1. Blok-Lok Limited: www.blok-lok.com.
 2. Hohmann & Barnard, Inc (including Dur-O-Wal brand): www.h-b.com.
 3. WIRE-BOND www.wirebond.com/#sle.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa), deformed billet bars; uncoated.
- C. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.
- D. Single Wythe Joint Reinforcement: Truss or ladder type; ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M, Class B; 0.1483 inch (3.8 mm) side

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rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage on each exposure. . Provide in lengths of not less than 10 feet (3 m),with prefabricated corner and tee units.

- E. Strap Anchors: Bent steel shapes, 1-1/2 inch (38 mm) width, 0.105 inch (2.7 mm) thick, 24 inch (610 mm) length, with 1-1/2 inch (38 mm) long, 90 degree bend at each end to form a U or Z shape or with cross pins, hot dip galvanized to ASTM A153/A153M Class B.

2.04 FLASHINGS

- A. See Section 076200 - Sheet Metal Flashing and Trim .

2.05 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
- B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding.
- C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, duel level, trapezoidal shape and designed to prevent mortar droppings from clogging cavity weeps and allow proper cavity drainage.
- D. Cavity Weeps : Polyester mesh.
- E. Color(s): As selected by Architect from manufacturer's full range.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142inch (3.6mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

2.06 MORTAR AND GROUT MIXES

- 1. Masonry below grade and in contact with earth: Type S.
- 2. Exterior, loadbearing masonry: Type S.
- 3. Exterior, non-loadbearing masonry: Type N.
- 4. Interior, loadbearing masonry: Type S.
- 5. Interior, non-loadbearing masonry: Type N.
- B. Mortar Type S: minimum 1800 psi, ASTM C 270.
- C. Mortar Type N: One (1) part Portland Cement, one (1) part hydrated lime, and six (6) parts sand.
- D. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.
- E. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches (50 mm) or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches (50 mm). Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 of ACI 530.1/ASCE 6/TMS 602 and ACI 530/ASCE 5 for dimensions of grout spaces and pour height. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
- F. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- G. Mixing: Use mechanical batch mixer and comply with referenced standards.

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2.07 SOURCE QUALITY CONTROL

- A. Owner may engage a qualified independent testing agency to perform source quality-control testing indicated below. Payment for these services will be made by Owner.
- B. Brick Tests: For each type and grade of brick indicated, units will be tested according to ASTM C 67.
- C. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 INSTALLATION - GENERAL

- A. Comply with ACI 530.1/ASCE 6, ACI 530/ASCE 5, and other requirements indicated applicable to each type of installation included in Project.
- B. Use full size units without cutting, if possible.
 - 1. 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.
 - 2. Allow units to dry before laying unless wetting of units is specified.
 - 3. Install cut units with cut surfaces and, where possible, cut edges concealed.
- C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets as they are placed.
- D. Wetting of Brick:
 - 1. Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67.
 - 2. Allow units to absorb water so they are damp but not wet at time of laying.
- E. Cover tops of all partially completed walls at end of day to protect completed work and prevent water from entering the cavity.
- F. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.04 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.05 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.

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B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:

1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches (200 mm).
3. Mortar Joints: Concave.

3.06 PLACING AND BONDING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- E. Interlock intersections and external corners.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Cut mortar joints flush where wall tile is scheduled, cement parging is required, or resilient base is scheduled. Use square outside corners where wall tile is scheduled or corner guards are shown. Use bullnose outside corners at typical outside CMU corner.
- I. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.07 WEEPS

- A. Install weeps in veneer and cavity walls at 16 inches (406 mm) on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.
- B. Place weeps directly on flashing.
- C. Do not strike mortar across bottom of weep.
 1. If mortar is struck across weep, remove and replace weep.

3.08 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

3.09 REINFORCEMENT AND ANCHORAGE - GENERAL, SINGLE WYTHE MASONRY, AND CAVITY WALL MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches (400 mm) on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches (150 mm).
- E. Reinforce joint corners and intersections with strap anchors 16 inches (400 mm) on center.

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- F. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 16 inches (400 mm) horizontally and 16 inches (400 mm) vertically.

3.10 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

- A. Install horizontal joint reinforcement 16 inches (400 mm) on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches (150 mm).

3.11 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 6 inches (152 mm), minimum, into adjacent masonry or turn up flashing ends at least 1 inch (25.4 mm), minimum, to form watertight pan at nonmasonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends with a minimum of two beads of continuous sealant from leading edge of horizontal surface across and up entire height of vertical/sloped surface. Seal penetrations of flashing before covering with mortar.
 - 4. Fold flashing to create end dams at discontinuous ends. Turn up one course.
 - 5. Seal penetrations of flashing materials at cast stone and other anchors with compatible sealant or mastic.
- B. Terminate flashing up 8 inches (203 mm) minimum on vertical surface of backing:
 - 1. Install vertical leg of flashing behind water-resistive barrier over backing.
 - 2. Anchor vertical leg of flashing into backing with a termination bar and sealant.
- C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.
- D. Extend metal flashings flush with the exterior face of masonry. Install flashing in two beads of butyl joint sealer Type 3 below flashing to prevent moisture migration under flashing. Refer to Section 079200 - Joint Sealants.
- E. Support flexible flashings across gaps and openings.
- F. Lap end joints of metal flashings at least 6 inches (152 mm) and seal watertight with Sealant Type 3.
 - 1. Refer to Sections 076200 - Sheet Metal Flashing and Trim and 079200 - Joint Sealants.

3.12 LINTELS

- A. Refer to structural drawings for lintel requirements.
- B. Install loose steel lintels over openings.
- C. Maintain minimum 8 inch (200 mm) bearing on each side of opening.

3.13 GROUTED COMPONENTS

- A. Reinforce bond beams as noted on the Contract Drawings.
- B. At bearing locations, fill masonry cores with grout for a minimum 12 inches (300 mm) either side of opening.
- C. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.14 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.

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- B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- C. Size control joints 3/8 inch wide and deep.
- D. Form expansion joint as detailed on drawings.

3.15 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, window frames, anchor bolts, plates, and louvers and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches (300 mm) from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.16 TOLERANCES

- A. Maximum Variation from Alignment of Columns: 1/4 inch (6 mm).
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch (1.6 mm).
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft (6 mm/3 m) and 1/2 inch in 20 ft (13 mm/6 m) or more.
- D. Maximum Variation from Plumb: 1/4 inch (6 mm) per story non-cumulative; 1/2 inch (13 mm) in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft (3 mm/m) and 1/4 inch in 10 ft (6 mm/3 m); 1/2 inch in 30 ft (13 mm/9 m).
- F. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch (minus 6.4 mm, plus 9.5 mm).
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch (6 mm).

3.17 CUTTING AND FITTING

- A. Cut and fit for chases, other items, pipes, other items, conduit, other items, sleeves, other items, grounds, other items, and other items. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.18 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.19 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.

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D. Use non-metallic tools in cleaning operations.

3.20 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 042000

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SECTION 055000
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel items.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Paint finish.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

- A. Bumper Guard Rails: As detailed; prime paint finish.

2.04 FINISHES - STEEL

- A. Prime paint steel items.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.

2.05 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
- C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
- D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
- E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

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3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION 055000

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SECTION 061000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sheathing.
- B. Preservative treated wood materials.
- C. Fire retardant treated wood materials.
- D. Communications and electrical room mounting boards.
- E. Concealed wood blocking, nailers, and supports.

1.02 RELATED REQUIREMENTS

- A. Section 062000 - Finish Carpentry
- B. Section 072500 - Weather Barriers: Water-resistive barrier over sheathing.
- C. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F. ASTM D2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. AWP A U1 - Use Category System: User Specification for Treated Wood; 2012.
- I. PS 1 - Structural Plywood; 2009.
- J. PS 2 - Performance Standard for Wood-Based Structural-Use Panels; 2010.
- K. PS 20 - American Softwood Lumber Standard; 2010.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and all items listed under products.
- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a two-year period commencing on Date of Substantial Completion.

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PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Douglas Fir-Larch, unless otherwise indicated.
 - 2. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 4. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Roof Sheathing: PS type, rated Structural I Sheathing.
 - 1. Bond Classification: Exterior.
 - 2. Span Rating: 48.
 - 3. Performance Category: 3/4 PERF CAT.
 - 4. Edge profile: Square edges, with panel clips
- B. Wall Sheathing: PS-1 type.
 - 1. Bond Classification: Exterior.
 - 2. Grade: Structural I Sheathing.
 - 3. Span Rating: 24.
 - 4. Performance Category: 3/4 PERF CAT.
 - 5. Edge Profile: Square edge.
- C. Gypsum Wall Sheathing: See Section 092116.
- D. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- E. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 - 3. Other Locations: PS 1, C-D Plugged or better.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete.

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2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWP A U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWP A standards.
- B. Fire Retardant Treatment:
 - 1. Products:
 - a. Arxada: www.arxada.com.
 - b. Hoover Treated Wood Products, Inc: www.frtw.com/#sle.
 - c. Koppers, Inc: www.koppersperformancechemicals.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Exterior Type: AWP A U1, Category UC FB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat exterior rough carpentry items where indicated.
 - c. Do not use treated wood in direct contact with the ground.
 - 3. Interior Type A: AWP A U1, Use Category UC FA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Treat communications and electrical room mounting boards.
 - d. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Products:
 - a. Arxada; ____ ; Wolman AG: www.arxada.com.
 - b. Koppers Performance Chemicals, Inc; MicroPro: www.koppersperformancechemicals.com/#sle.
 - c. Viance, LLC; Ecolife: www.treatedwood.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber exposed to weather.
 - c. Treat lumber in contact with flashing or waterproofing.
 - d. Treat lumber in contact with masonry or concrete.
 - e. Treat lumber less than 18 inches (450 mm) above grade.

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- f. Treat lumber in other locations as indicated.
3. Preservative Pressure Treatment of Plywood Above Grade: AWP U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with flashing or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.
 - d. Treat plywood less than 18 inches (450 mm) above grade.
 - e. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.
- D. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- E. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.
- F. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- G. Separate preservative-treated wood from metal framing and aluminum with felt paper, 10-mil polyethylene sheet, or self-adhered transition membrane products (See Section 072500).
- H. Provide the following specific nonstructural framing and blocking:
 1. Cabinets and shelf supports.
 2. Wall brackets.
 3. Handrails.
 4. Grab bars.
 5. Towel and bath accessories.
 6. Wall-mounted door stops.
 7. Chalkboards and marker boards.
 8. Wall paneling and trim.
 9. Joints of rigid wall coverings that occur between studs.
 10. TV and monitor mounts..

3.02 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
- B. Provide wood curb at each roof opening except where prefabricated curbs are specified and where specifically indicated otherwise; form corners by alternating lapping side members.

3.03 INSTALLATION OF CONSTRUCTION PANELS

- A. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.

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1. Nail panels to framing; staples are not permitted.
 - B. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.
 1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.
 - C. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 3. Install adjacent boards without gaps.
- 3.04 SITE APPLIED WOOD TREATMENT
- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
 - B. Allow preservative to dry prior to erecting members.
- 3.05 TOLERANCES
- A. Framing Members: 1/4 inch (6 mm) from true position, maximum.
 - B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.
- 3.06 CLEANING
- A. Waste Disposal: See Section 017419 - Construction Waste Management and Disposal.
 1. Comply with applicable regulations.
 2. Do not burn scrap on project site.
 - B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

END OF SECTION 061000

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**SECTION 072100
THERMAL INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Batt insulation in exterior wall and wall construction.

1.02 RELATED REQUIREMENTS

- A. Section 075300 - Elastomeric Membrane Roofing: Insulation specified as part of roofing system.
- B. Section 092116 - Gypsum Board Assemblies: Acoustic insulation inside walls and partitions.

1.03 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2009a.
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. ASTM F2169 - Standard Specification for Resilient Stair Treads; 2015.
- E. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, product limitations, and other relevant data.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.05 QUALITY ASSURANCE

- A. Thermal Resistivity: Where thermal resistivity properties of insulation materials are designated by r-values, they represent the rate of heat flow through a homogenous material exactly 1" thick, measured by test method included in referenced material standard or otherwise indicated. They are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperature indicated.

PART 2 PRODUCTS

2.01 INSULATION TYPES

- A. General
 - 1. The categorizations of thermal barriers by location, form, and application in this Article are general descriptions only. Refer to the Drawings and other Sections for specific requirements.
- B. Type 1: Mineral fiber batt insulation with no vapor retarder.
 - 1. Application: Thermal insulation.
 - 2. Location: Stud cavities of exterior metal-framed walls.

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2.02 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Type 1: Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
 - 3. Thermal Resistance: R-value (RSI-value) of 4.0 per inch (____).
 - 4. Products:
 - a. Johns Manville; Mineral Wool TempControl Batts: www.jm.com/#sle.
 - b. ROCKWOOL; COMFORTBATT: www.rockwool.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.03 ACCESSORIES

- A. Insulation Fasteners: Impaling clip of galvanized steel with washer retainer and clips and clips, to be mechanically fastened to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BATT INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.03 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

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SECTION 074113
METAL ROOF PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal roof panel system of preformed aluminum panels.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Roof sheathing.
- B. Section 079200 - Joint Sealants: Sealing joints between metal roof panel system and adjacent construction.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.
- C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- D. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2009.
- E. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2012).
- F. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems; 2012.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Specimen warranty.
- C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 - 1. Show work to be field-fabricated or field-assembled.
- D. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches (305 mm) square, representing actual roofing metal, thickness, profile, color, and texture.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Test Reports: Indicate compliance of metal roofing system to specified requirements.
- I. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

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1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section and with at least three years of documented experience.
 - 1. Accredited by IAS in accordance with IAS AC472.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.
- B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.07 FIELD CONDITIONS

- A. Do not install metal roof panels, eave protection membrane, underlayment, or _____ when surface, ambient air, or wind chill temperatures are below 45 degrees F (7 degrees C).

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Architectural Metal Roof Panel Manufacturers:
 - 1. Petersen Aluminum Corporation; R-36 panels: www.pac-clad.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
 - a. Dead Loads: Weight of roofing system.
 - b. Live Loads: As required by ASCE 7.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F (56 degrees C).

2.03 METAL ROOF PANELS

- A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Aluminum Panels:
 - a. Alloy and Temper: Aluminum complying with ASTM B209/B209M; temper as required for forming.
 - b. Thickness: Minimum 18 gauge, 0.040 inch (1.0 mm).
 - 2. Profile: Lapped seam, with integral sealant bead and exposed fastener system.

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3. Texture: Smooth.
4. Length: As indicated on drawings.
5. Width: Maximum panel coverage of 36 inches (___ mm).

2.04 ATTACHMENT SYSTEM

- A. Exposed System: Provide manufacturer's recommended stainless steel fasteners engineered to meet performance requirements and equipped with appropriate sealant separators to provide weathertight connections that will accommodate anticipated thermal movement.

2.05 FABRICATION

- A. Panels: Provide factory or field fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.
- B. Joints: Provide captive gaskets, sealants, or separator strips at panel joints to ensure weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

2.06 FINISHES

- A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); color and gloss match existing.
 1. Products:
 - a. Arkema, Inc; Kynar 500: www.arkema.com/#sle.
 - b. Beckers Group; Beckry Fluor: www.beckers-group.com/#sle.
 - c. PPG; Duranar: www.ppgmetalcoatings.com/#sle.
 - d. Sherwin-Williams Company; Fluoropon: www.coil.sherwin.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.07 ACCESSORIES

- A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
 1. Downspouts: match existing.
- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of closed-cell synthetic rubber, neoprene, or PVC.
- C. Sealants:
 1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
 2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
 3. Seam Sealant: Factory-applied, non-skinning, non-drying type.
- D. Underlayment for Wood Substrate: ASTM D226/D226M roofing felt, perforated type; covered by water-resistant rosin-sized building paper.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

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- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Broom clean wood sheathing prior to installation of roofing system.
- B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.
- C. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.
- D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.
- E. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
 - 1. Install roofing system with exposed fasteners prefinished to match panels.
 - 2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.
- B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Install roofing felt and building paper slip sheet on roof sheathing before installing preformed metal roof panels; secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners; apply from eaves to ridge in shingle fashion, overlapping horizontal joints at least 2 inches (50 mm) and side and end laps at least 3 inches (75 mm); offset seams in building paper and seams in roofing felt.
- D. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.

3.04 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION

- A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION 074113

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SECTION 075323

EPDM THERMOSET SINGLE-PLY ROOFING - CARLISLE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Adhered roof system with ethylene propylene diene monomer (EPDM) roofing membrane.
- B. Insulation, flat and tapered.
- C. Deck sheathing.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's written information listed below.
 - 1. Product data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements.
- C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
- D. Specimen Warranty: For approval.
- E. Warranty:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- B. Protect products in weather protected environment, clear of ground and moisture.
- C. Protect foam insulation from direct exposure to sunlight.
- D. Keep Safety Data Sheets (SDS) at the project site at all times during transportation, storage, and installation of materials.
- E. Comply with requirements from Owner to prevent overloading or disturbance of the structure when loading materials onto the roof.

1.04 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather. Refer to manufacturer's written instructions.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F (5 degrees C) or above ____ degrees F (____ degrees C).
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- E. Proceed with work so new roofing materials are not subject to construction traffic as work progresses.

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F. Do not allow grease, oil, fats, or other contaminants to come into direct contact with membrane.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 10 years after installation.
- C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 - 1. Warranty Term: 20 years.
 - 2. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carlisle SynTec Systems: www.carlisle-syntec.com/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.

2.02 ROOFING APPLICATIONS

- A. EPDM Membrane Roofing: One ply membrane, fully adhered, over insulation.
- B. Roofing Assembly Performance Requirements and Design Criteria:
 - 1. Wind Uplift:
 - a. Designed to withstand wind uplift forces calculated with ASCE 7.
 - b. Design Wind Speed: In accordance with local building code and authorities having jurisdiction (AHJ).
 - 2. Insulation Thermal Resistance (R-Value): Provide R-Value over entire roof deck in accordance with local building code requirements.
 - 3. Drainage: No standing water within 48 hours after precipitation.

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

- A. Membrane:
 - 1. Material: Ethylene propylene diene monomer (EPDM); ASTM D4637/D4637M, Type I (non-reinforced).
 - 2. Thickness: 90 mil, 0.090 inch (2.3 mm), minimum.
 - 3. Sheet Width: Factory fabricated into largest sheets possible.
 - 4. Color: White on Black.
 - 5. Products:
 - a. Carlisle SynTec Systems; Sure-White.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Membrane Fasteners: As recommended and approved by membrane manufacturer.
- D. Flexible Flashing Material: Same material as membrane.
- E. Base Flashing: Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations.

2.04 DECK SHEATHING AND COVER BOARDS

2.05 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: ASTM C1289, Type II, Class 1 - Faced with glass fiber reinforced cellulosic felt facers on both major surfaces of the core foam; Grade 1.
 - 1. Compressive Strength: 16 psi (110 kPa).

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2.06 ACCESSORIES

- A. Prefabricated Flashing Accessories:
 - 1. Corners and Seams: Same material as membrane, in manufacturer's standard thicknesses.
 - 2. Penetrations: Same material as membrane, with manufacturer's standard cut-outs, rigid inserts, clamping rings, and flanges.
 - 3. Sealant Pockets: Same material as membrane, with manufacturer's standard accessories, in manufacturer's standard configuration.
 - 4. Carlisle SynTec Systems; Sure-Seal Pressure-Sensitive Reinforced Universal Securement Strip (RUSS):
 - 5. Sure-White Pressure-Sensitive Reinforced Universal Securement Strip (RUSS): 6 inches (152 mm) wide, 45 mil, 0.045 inch (1.1 mm) thick, reinforced EPDM membrane with 3 inches (76 mm) wide, 30 mil, 0.030 inch (0.76 mm) thick cured synthetic rubber with pressure-sensitive adhesive laminated to one edge.
- B. Insulation Adhesive: Two component polyurethane, expanding foam.
- C. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches (152 mm) wide; self-adhering.
- D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
- E. Membrane Adhesive: As recommended by membrane manufacturer.
- F. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- G. Sealants: As recommended by membrane manufacturer.
- H. Cleaner: Manufacturer's standard, clear, solvent-based cleaner.
- I. Edgings and Terminations: Manufacturer's standard edge and termination accessories.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 PREPARATION, GENERAL

- A. Clean substrate thoroughly prior to roof application.
- B. Apply manufacturer's recommended vapor retarder or temporary roof before roof installation.

3.03 WOOD DECK PREPARATION

- A. Verify flatness and tightness of joints of wood decking. Verify that all wood decking edges are fully supported. Fill knot holes with latex filler or completely cover with securely nailed sheet metal.

3.04 INSTALLATION - GENERAL

- A. Perform work in accordance with manufacturer's instructions.
- B. Do not apply roofing membrane during unsuitable weather.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

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- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.05 VAPOR RETARDER INSTALLATION

- A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

3.06 INSULATION APPLICATION

- A. Attachment of Insulation:
- B. Attachment of Insulation: Embed insulation in adhesive in full contact, in accordance with roofing and insulation manufacturer's instructions.
- C. Lay subsequent layers of insulation with joints staggered minimum 6 inches (152 mm) from joints of preceding layer.
- D. Lay boards with edges in moderate contact without forcing, and gap between boards no greater than 1/4 inch (6.4 mm). Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- E. Tape joints of insulation in accordance with roofing and insulation manufacturers instructions.
- F. Do not apply more insulation than can be completely waterproofed in the same day.

3.07 MEMBRANE APPLICATION

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Fully Adhered Application: Apply adhesive at manufacturer's recommended rate. Fully embed membrane in adhesive except in areas directly over or within 3 inches (76 mm) of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches (76 mm). Seal permanently waterproof.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches (102 mm) onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.

3.08 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove wrappings, empty containers, paper, and other debris from the roof daily. Dispose of debris in compliance with local, State, and Federal regulations.
- C. Remove bituminous markings from finished surfaces.
- D. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

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- E. Repair or replace defaced or damaged finishes caused by work of this section.

END OF SECTION 075323

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SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS

- A. Section 042000 - Unit Masonry: Installation of flashing materials embedded in masonry.
- B. Section 072500 - Weather Barriers: Installation of weather barriers and interface with flashing materials.
- C. Section 075300 - Elastomeric Membrane Roofing: Flashings for membrane roofing
- D. Section 077123 - Manufactured Gutters and Downspouts.

1.03 REFERENCE STANDARDS

- A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2015b.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- D. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- F. ASTM D2178/D2178M - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing; 2013a.
- G. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2012).
- H. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Samples: Submit two samples 6 by 6 inch (____ by ____ mm) in size illustrating metal finish color.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Maintain one copy of each document on site.
- C. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

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1.07 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Pre-Finished Aluminum: ASTM B209 (ASTM B209M); 20 gage (0.032 inch) (0.81 mm) thick; plain finish shop pre-coated with fluoropolymer coating.
 - 1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As selected by Architect from manufacturer's full colors.
- B. Stainless Steel: ASTM A666, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch (0.40 mm) thick; smooth No. 4 - Brushed finish.

2.02 FLASHING TYPES

- A. Flashing Type 1: Two-piece interlocking type:
 - 1. Material: Stainless steel.
 - 2. Configurations shall be as shown on drawings.
 - 3. Where cap flashings or counter flashings occur, they shall be of two-piece construction with a receiver having a special vertical locking slot that requires no malleting or bending to hold the insert member in place.
 - 4. Keyed or corrugated flashings are unacceptable.
 - 5. Where flashings do not turn up behind walls, terminate with a 1/4" hook dam.
 - 6. Thru-wall flashings at parapets shall be hemmed flush with the exposed face of face brick.
 - 7. Fasteners, mastic for sealing and attachment, etc., shall be as recommended by the manufacturer.
- B. Flashing Type 2: Masonry thru-wall type:
 - 1. Stainless steel : ASTM A666 Type 304, soft temper, 0.015 inch (0.4 mm) thick; smooth No. 4 finish.
 - 2. Configurations shall be as shown on drawings.
 - 3. Installation: Refer to Section 042000 - Unit Masonry.
- C. Flashing Type 2A – Masonry thru-wall type:
 - 1. Material: Stainless steel core flexible flashing with drainage fabric; with continuous stainless steel drip edge.
 - 2. Product standard of quality: York Manufacturing, Inc.; York Multi-Flash SS 304.
 - a. Substitutions: See Section 01 60 00.
 - 3. Characteristics:
 - a. Type: Stainless steel core with polymer fabric laminated to the bottom stainless steel face with non-asphalt adhesive. The top face (exposed side) must not be covered with a polymer fabric.
 - b. Stainless steel: Type 304, ASTM A240
 - 4. Fabric: polymer fabric; laminated back face (non-exposed side) of stainless steel core.
 - 5. Accessories:
 - a. Mastic/sealant: Product standard of quality is York Manufacturing, Inc.; UniverSeal US100.
 - b. Drip edges, outside corner and inside corner material: manufacturer's standard available units using 26-gauge stainless steel.

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- c. End dams: Utilize pre-formed end dams by manufacturer using 26-gauge stainless steel.
 - d. Splice material: Product standard of quality is York 304 SS by York. Manufacturer's standard self-adhered metal material: material matching system material or use Multi-Flash Stainless Steel 6" lap piece and polyether sealant as a splice.
 - e. Termination bar: Product standard of quality is York T-96 termination bar. Manufacturer's standard 1" composite material bar or a 1" 26-gauge stainless steel termination bar with sealant lip.
 - 6. Configuration shall be as shown on drawings.
 - 7. Installation: Refer to Section 04 20 00 – Unit Masonry
 - D. Flashing Type 2B: Masonry thru-wall type.
 - 1. Stainless Steel/Polymer Fabric Drainage Plane Flashing - Self-Adhering: ASTM A240/A240M; 2 mil (0.05 mm) type 304 stainless steel sheet with co-polymer butyl adhesive and a removable release liner on one side and a sheet of nonwoven drainage material bonded to the other side.
 - a. Manufacturers:
 - 1) York Manufacturing, Inc; Flash-Vent SA: www.yorkmfg.com/#sle.
 - 2) Substitutions: See Section 016000 - Product Requirements.
 - 2. Configurations shall be as shown on drawings.
 - 3. Installation: Refer to Section 042000 - Unit Masonry .
 - E. Flashing Type 3: Membrane roofing base flashing material as specified in Section 075300 - Elastomeric Membrane Roofing .
 - F. Flashing Type 4: Formed metal flashing (Other than Type 1):
 - 1. Material: Stainless steel.
 - 2. Configurations shall be as shown on drawings.
- 2.03 ACCESSORIES
- A. Fasteners: Stainless steel, with soft neoprene washers.
 - B. Outside corner and inside corner material; manufacturer's standard available units using:
 - 1. Stainless steel: 26 gauge stainless steel.
 - C. End dam: Utilize preformed end dams by manufacturer using:
 - 1. Stainless steel: 26 gauge stainless steel
 - D. Sealant to be Concealed in Completed Work: Type 3 as specified in Section 079200.
 - E. Sealant to be Exposed in Completed Work: Type 1 as specified in Section 079200.
 - F. Reglets: Surface mounted type, galvanized steel; face and ends covered with plastic tape.
 - G. Termination Bars: 1 inch wide (25 mm) x 1/8 inch thick (3 mm); stainless steel.
- 2.04 FABRICATION
- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
 - B. Form pieces in longest possible lengths.
 - C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
 - D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
 - E. Fabricate vertical faces with bottom edge formed outward 3/4 inch (19 mm) and hemmed to form drip.
 - F. Fabricate flashings to allow toe to extend 4 inches (101 mm) over roofing membrane. Return and brake edges.

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2.05 GUTTERS AND DOWNSPOUTS

- A. See Section 077123 for manufactured gutters and downspouts.

2.06 ACCESSORIES

- A. Fasteners: Stainless steel, with soft neoprene washers.
- B. Primer Type: Zinc chromate.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.
- F. Solder: ASTM B32, Alloy Grade - Sn50 (50/50).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.03 INSTALLATION

- A. Conform to drawing details and to the following:
 - 1. SMACNA Architectural Sheet Metal Manual,
- B. Insert flashings into reglets to form tight fit; secure in place with plastic wedges; seal flashings into reglets with sealant.
- C. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- D. Apply plastic cement compound between metal flashings and felt flashings.
- E. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- F. Fasten cavity wall flashings to stud back-up with a non-corrosive termination bar and seal the top edge of the flashing with sealant.
- G. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION 076200

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SECTION 077123
MANUFACTURED GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pre-finished aluminum gutters and downspouts.
- B. Aluminum downspout shoes.
- C. Precast concrete splash pads.

1.02 RELATED REQUIREMENTS

- A. Section 076200 - Sheet Metal Flashing and Trim.
- B. Section 077100 - Roof Specialties : Roof fascia and copings

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on prefabricated components.
- C. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.
- D. Samples: Submit two samples, 12 inch (304 mm) long illustrating component design, finish, color, and configuration.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.
- B. Prevent contact with materials that could cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Gutters and Downspouts:
 - 1. Hickman Edge Systems: www.hickmanedgesystems.com/#sle.
 - 2. Metal-Era Inc; Seal-Tite Gold Industrial Gutter: www.metalera.com.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Pre-Finished Aluminum Sheet: ASTM B209/B209M; 0.050 inch (1.27 mm) thick.
 - 1. Finish: Plain, shop pre-coated with polyvinylidene fluoride (PVDF) coating.
 - 2. Color: To match copings and fascia..

2.03 COMPONENTS

- A. Downspouts: Profile as indicated on drawings.
- B. Anchors and Supports: Profiled to suit gutters and downspouts.
- C. Fasteners: Stainless steel, with soft neoprene washers.

2.04 FABRICATION

- A. Form gutters and downspouts of profiles and size indicated.

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- B. Fabricate with required connection pieces.
- C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
- D. Hem exposed edges of metal.
- E. Fabricate gutter and downspout accessories; seal watertight.

2.05 FINISHES

- A. Fluoropolymer Coating: Superior Performance Organic Finish, AAMA 2605, multiple coat, thermally cured fluoropolymer finish system; color as indicated.
- B. Primer Coat: Finish concealed side of metal sheets with primer compatible with finish system, as recommended by finish system manufacturer.

2.06 ACCESSORIES

- A. Splash Pads: Precast concrete type, profiles size(s) as indicated; minimum 3,000 psi (21 MPa) compressive strength at 28 days, with minimum 5 percent air entrainment.
- B. Downspout Shoes: Smooth interior without boxed corners or choke points; include integral lug slots and internal debris grate with cleanout door.
 - 1. Configuration: Angular.
 - 2. Height: 30 inches.
 - 3. Material: Aluminum.
 - 4. Finish: Manufacturer's standard factory applied powder coat finish.
 - 5. Accessories: Manufacturer's standard stainless steel building wall anchors.
 - 6. Locations: Provide at downspout transitions to roof drainage piping. Refer to Drawings for additional information.
 - 7. Products:
 - a. Piedmont Downspout Adapters, SO Series, by Piedmont Pipe Construction, Inc.: www.piedmontpipe.com.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that surfaces are ready to receive work.

3.02 PREPARATION

- A. Paint concealed sheet metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.381 mm).

3.03 INSTALLATION

- A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.
- B. Sheet Metal: Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.
- C. Set splash pads under downspouts.

END OF SECTION 077123

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DIVISION 07 SECTION 07 84 13
FIRE PROTECTION, HVAC & PLUMBING PENETRATION FIRESTOPPING
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SECTION 07 84 13 - 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.

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.

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 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+
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

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
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.

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**SECTION 079200
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 071300 - Sheet Waterproofing: Sealing cracks and joints in waterproofing substrate surfaces using materials specified in this section.
- B. Section 072500 - Weather Barriers: Sealants required in conjunction with air barriers and vapor retarders.
- C. Section 078400 - Firestopping: Firestopping sealants.
- D. Section 079513 - Expansion Joint Cover Assemblies: Sealants forming part of expansion joint cover assemblies.
- E. Section 087100 - Door Hardware: Setting exterior door thresholds in sealant.
- F. Section 088000 - Glazing: Glazing sealants and accessories.
- G. Section 092116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.
- H. Section 093000 - Tiling: Sealant between tile and plumbing fixtures and at junctions with other materials and changes in plane.

1.03 SUBMITTALS

- A. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
- B. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- D. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.
- E. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.
- F. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- G. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.
- H. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

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1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- D. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
 1. Identification of testing agency.
 2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
 - a. Test date.
 - b. Copy of test method documents.
 - c. Age of sealant upon date of testing.
 - d. Test results, modeled after the sample form in the test method document.
 - e. Indicate use of photographic record of test.
- E. Field Quality Control Plan:
 1. Visual inspection of entire length of sealant joints.
 2. Non-destructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
 3. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant.
 - a. For each different sealant and substrate combination, allow for one test every 100 feet (30 meters) in the first 1000 linear feet (305 linear meters), and one test per 1000 linear feet (305 meters) thereafter, or once per floor on each elevation.
 - b. If any failures occur in the first 1000 linear feet (305 linear meters), continue testing at frequency of one test per 500 linear feet (152 linear meters) at no extra cost to Owner.
 4. Field testing agency's qualifications.
 5. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- F. Field Adhesion Test Procedures:
 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 2. Have a copy of the test method document available during tests.
 3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 4. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
 5. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
 6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
- G. Non-Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.

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- H. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.
1. Sample: At least 18 inch (457 mm) long.
 2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch (25 mm) by that percentage; if adhesion failure occurs before the "1 inch mark" is that distance from the substrate, the test has failed.
 3. If either adhesive or cohesive failure occurs prior to minimum elongation, take necessary measures to correct conditions and re-test; record each modification to products or installation procedures.

1.05 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion.
- B. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

- A. Scope:
 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Joints between plumbing fixtures and adjacent construction.
 2. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 3. Do not seal the following types of joints.
 - a. Intentional weepholes in masonry.
 - b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
- B. Exterior Joints: Use non-sag non-staining silicone sealant, Type 1, unless otherwise indicated.
 1. Type 3 - Lap Joints in Sheet Metal Fabrications: Butyl rubber, non-curing.
 2. Interior Expansion and Control Joints: Polyurethane sealant; Type 1A.
 3. Interior Joints at windows, storefront and curtainwall: Polyurethane sealant; Type 1A.
 4. Fire-rated Construction: ASTM C 834, UL Listed.
 5. In Sound-Rated Assemblies: Acoustical sealant; Type 5.
 6. Type 7 - Narrow Control Joints in Interior Concrete Slabs Exposed to View: Self-leveling polyurea sealant.
 7. Interior Wet Areas: Type 6 - Mildew-Resistant Silicone Sealant: not expected to withstand continuous water immersion or traffic. Bathrooms, restrooms, kitchens, food service areas, and food processing areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.
- C. Sealant Types Summary:
 1. Type 1: Non-Staining Silicone.
 2. Type 1A: Polyurethane.
 3. Type 2: Acrylic Emulsion Latex
 4. Type 3: Non-Curing Butyl Sealant
 5. Type 4: Fire resistant foam sealant: Refer to Section 078400 - Firestopping.

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6. Type 5: Acoustical Sealant
7. Type 6: Mildew-Resistant Silicone Sealant
8. Type 7: Self-Leveling Polurea Sealant

2.02 NONSAG JOINT SEALANTS

- A. Type 1 - Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
 2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 4. Color: To be selected by Architect from manufacturer's standard range.
 5. Cure Type: Single-component, neutral moisture curing.
 6. Service Temperature Range: Minus 65 to 180 degrees F (Minus 54 to 82 degrees C).
 7. Manufacturers:
 - a. Dow Chemical Company; 795 Silicone Building Sealant: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - b. Sika Corporation; Sikasil WS-295: www.usa-sika.com/#sle.
 - c. Pecora Corporation; 890NST: www.pecora.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Type 1A - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
 1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 3. Color: To be selected by Architect from manufacturer's standard range.
 4. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).
 5. Manufacturers:
 - a. Pecora Corporation; DynaTrol 1-XL: www.pecora.com.
 - b. Sika Corporation; Sikaflex-15 LM: www.usa-sika.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Dymonic 100: www.tremcosealants.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Type 2 - Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
- D. Type 3 - Non-Curing Butyl Sealant: Solvent-based; ASTM C1311; single component, non-sag, non-skinning, non-hardening, non-bleeding; vapor-impermeable; intended for fully concealed applications.
- E. Type 4: Fire resistant foam sealant: Refer to Section 07 84 00 - Firestopping.
- F. Type 5 - Acoustical Sealant for Concealed Locations: ASTM C 834, UL Listed.
 1. Composition: Acrylic latex emulsion sealant.
 2. Applications: Use for concealed locations only:
 - a. Acoustical application: Sealant bead between top stud runner and structure and between bottom stud track and floor.
 3. Products:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant: www.pecora.com.
 - b. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant: www.us.hilti.com.
 - c. USG Company; Sheetrock Brand Acoustical Sealant; www.usg.com.

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- G. Type 6 - Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
 - 1. Color: White.
 - 2. Manufacturers:
 - a. Pecora Corporation: www.pecora.com.
 - b. Sika Corporation; Sikasil GP: www.usa-sika.com.

2.03 SELF-LEVELING SEALANTS

- A. Type 7 - Semi-Rigid Self-Leveling Polyurea Joint Filler: Two-component, 100 percent solids; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 - 1. Durometer Hardness, Type A: 75, minimum, after seven days when tested in accordance with ASTM D2240.
 - 2. Color: To be selected by Architect from manufacturer's standard colors.
 - 3. Joint Width, Minimum: 1/8 inch (3 mm).
 - 4. Joint Width, Maximum: 3/4 inch (19 mm).
 - 5. Joint Depth: Provide product suitable for joints from 1/8 inch (3 mm) to 1 inch (25.4 mm) in depth excluding space for backer rod.
 - 6. Manufacturers:
 - a. Adhesives Technology Corporation; Crackbond JF-311: www.atcepoxy.com/#sle.
 - b. ARDEX Engineered Cements; ARDEX ARDISEAL RAPID PLUS: www.ardexamericas.com/#sle.
 - c. Euclid Chemical Company; EUCO QWIKjoint UVR: www.euclidchemical.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.04 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
 - 1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
 - 2. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.
 - 3. Manufacturers:
 - a. Nomaco, Inc; SOF Rod: www.nomaco.com.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

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- D. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
 2. Notify Architect of date and time that tests will be performed, at least 7 days in advance.
 3. Record each test on Preinstallation Adhesion Test Log as indicated.
 4. If any sample fails, review products and installation procedures, consult manufacturer, or take whatever other measures are necessary to ensure adhesion; re-test in a different location; if unable to obtain satisfactory adhesion, report to Architect.
 5. After completion of tests, remove remaining sample material and prepare joint for new sealant installation.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 1. Width/depth ratio of 2:1.
 2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.04 FIELD QUALITY CONTROL

- A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- B. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet (30 linear m), notify Architect immediately.
- C. Destructive Adhesion Testing: If there are any failures in first 1000 linear feet (300 linear m), notify Architect immediately.
- D. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

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3.05 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at low temperature in thermal cycle. Report failures immediately and repair.

END OF SECTION 079200

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SECTION 092116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation installation.
- E. Gypsum sheathing.
- F. Gypsum wallboard.
- G. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.
- B. Section 072100 - Thermal Insulation: Acoustic insulation.
- C. Section 072500 - Weather Barriers: Water-resistive barrier over sheathing.
- D. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016.
- B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.
- C. AISI S220 - North American Standard for Cold-Formed Steel Framing - Nonstructural Members; 2015.
- D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015.
- E. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- G. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2011a.
- I. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2015.
- J. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2015.
- K. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2013.
- L. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2015.
- M. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2014.

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- N. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base; 2014a.
- O. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2013.
- P. ASTM C1278/C1278M - Standard Specification for Fiber-Reinforced Gypsum Panel; 2007a (Reapproved 2011).
- Q. ASTM C1280 - Standard Specification for Application of Gypsum Sheathing Board; 2013.
- R. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2014.
- S. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2015.
- T. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2013.
- U. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.
- V. GA-216 - Application and Finishing of Gypsum Board; 2013.
- W. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on metal framing, gypsum board, glass mat faced gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Steel Framing Industry Association (SFIA) Certification:
 - 1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.
- D. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

1.05 QUALITY ASSURANCE

- A. SFIA Code Compliance Certification Program: www.CFSteel.org/#sle: Use metal studs and connectors certified for compliance with International Building Code.
- B. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.

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1. See PART 3 for finishing requirements.
- B. Grid Suspension Systems: Provide grid suspension systems in accordance with ASTM C840 and GA-216.

2.02 METAL FRAMING MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
 1. Structural Grade: As required to meet design criteria.
 2. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- C. Manufacturers - Metal Framing, Connectors, and Accessories:
 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 2. MarinoWARE: www.marinoware.com/#sle.
 3. Phillips Manufacturing Co: www.phillipsmfg.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- D. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf (L/240 at 240 Pa).
 1. Studs: C-shaped with knurled or embossed faces with knurled or embossed faces.
 2. Gauge: 33 mil (20 gage) minimum
 3. Runners: U shaped, sized to match studs.
 4. Ceiling Channels: C-shaped.
 5. Flexible Track: Flexible framing consisting of adjustable leg straps and pivoting, hinged track brackets designed to provide curved framing assemblies of varying radii.
- E. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- F. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
 3. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.
 - a. Products:
 - 1) ClarkDietrich; BlazeFrame RipTrak: www.clarkdietrich.com/#sle.
 - 2) FireTrak Corporation; Posi Klip: www.fire-trak.com/#sle.
 - 3) Metal-Lite, Inc; The System: www.metal-lite.net/#sle.
 - 4) Super Stud Building Products, Inc; Slotted Deflection Track: www.buysuperstud.com/#sle.
 - 5) Substitutions: See Section 016000 - Product Requirements.
- G. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
 1. Products:
 - a. CertainTeed Corporation: www.certainteed.com/ceilings-and-walls/#sle.
 - b. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - c. Armstrong World Industries, Inc.: www.armstrongceilings.com.

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- d. Chicago Metallic Drywall Grid System: www.rockfon.com.
- e. Substitutions: See Section 016000 - Product Requirements.
- 2. General:
 - a. Classification: ASTM C-635 Heavy duty classification
 - b. Use G90 galvanized components for exterior applications.
- 3. Components:
 - a. Main Beam: double-web construction (minimum 0.0179 inch prior to protective coating, ASTM C645), hot dipped galvanized (per ASTM A653); 1-11/16 inch web height, 1-1/2 inch flange.
 - b. Primary Cross Tees: double-web steel construction (minimum 0.0179 inch prior to protective coating, ASTM C645), hot dipped galvanized (per ASTM A653); 1-1/2 inch web height with rectangular bulb and pre-finished 1-1/2 inch knurled flange
 - c. Wall Molding: Locking Angle Molding, 1-1/4 inch x 1-1/4 inch with pre-engineered locking tabs punched 8 inches on center, knurled surface, screw stop hem, pre-punched holes in top flange, 4" O.C., .018 mil.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 3. Gold Bond Building Products, LLC provided by National Gypsum Company: www.goldbondbuilding.com/#sle.
 - 4. USG Corporation: www.usg.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, 10'-0" and higher, unless otherwise indicated. Use for inner layer of multi-layer applications, unless otherwise indicated.
 - 2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required at all locations.
 - 4. Type: Fire-resistance-rated Type X, UL or WH listed.
 - 5. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).
 - b. Ceilings: 5/8 inch (16 mm).
 - 6. Mold-Resistant, Paper-Faced Products:
 - a. CertainTeed Corporation; M2Tech 5/8" Type X Moisture & Mold Resistant Drywall: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - c. USG Corporation; Sheetrock Brand EcoSmart Panels Mold Tough Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 7. Glass Mat Faced Products:
 - a. CertainTeed Corporation; 5/8" GlasRoc Interior Type X: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Interior Extreme Fire-Shield Gypsum Panel: www.goldbondbuilding.com/#sle.

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- c. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough Regular 5/8 in. (15.9 mm): www.usg.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Abuse Resistant Wallboard:
 - 1. Application: In all locations up to 10'-0" AFF, unless otherwise noted.
 - 2. Surface Abrasion: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 4. Soft Body Impact: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 5. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 6. Type: Fire-resistance-rated Type X, UL or WH listed.
 - 7. Thickness: 5/8 inch (16 mm).
 - 8. Edges: Tapered.
 - 9. Paper-Faced Products:
 - a. CertainTeed Corporation; Extreme Abuse Resistant Drywall with M2Tech: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold Guard Abuse-Resistant: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Hi-Abuse Gypsum Board: www.goldbondbuilding.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 10. Glass Mat Faced Products:
 - a. Georgia-Pacific Gypsum; DensArmor Plus Abuse-Resistant: www.gpgypsum.com/#sle.
 - b. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough AR Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- D. Impact Resistant Wallboard:
 - 1. Application: Gypsum board partitions in Gymnasium; other locations as indicated.
 - 2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 4. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 5. Hard Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 6. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 7. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
 - 8. Glass Mat-Faced Type: Gypsum wallboard, as defined in ASTM C1658/C1658M.
 - 9. Unfaced Type: Interior fiber-reinforced gypsum panels, as defined in ASTM C1278/C1278M.
 - 10. Type: Fire-resistance-rated Type X, UL or WH listed.
 - 11. Thickness: 5/8 inch (16 mm).
 - 12. Edges: Tapered.
 - 13. Paper-Faced Products:
 - a. CertainTeed Corporation; Extreme Impact Resistant Drywall with M2Tech: www.certainteed.com/#sle.

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- b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Hi-Impact Gypsum Board: www.goldbondbuilding.com/#sle.
 - c. USG Corporation; Sheetrock Brand Mold Tough VHI Firecode X Panels 5/8 in. (15.9 mm): www.usg.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- E. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
 - 1. Application: Exterior sheathing, unless otherwise indicated.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 - 4. Core Type: Type X, all locations
 - 5. Type X Thickness: 5/8 inch (16 mm).
 - 6. Edges: Square.
 - 7. Glass Mat Faced Products:
 - a. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
 - d. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.04 GYPSUM BOARD ACCESSORIES

- A. Water-Resistive Barrier: See Section 072500.
- B. Beads and Beads: ASTM C1047, paper-faced galvanized steel , unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. Expansion Joints:
 - a. Fire-Resistance Rated: 2 hours when joint system tested in accordance with UL 2079.
 - b. Type: V-shaped metal with factory-installed protective tape.
- C. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Fiberglass Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 - 2. Joint Compound: Setting type, field-mixed.
- D. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
 - 1. Products:
 - a. CertainTeed Corporation; Level V Wall and Ceiling Primer/Surfer with M2Tech: www.certainteed.com/#sle.
 - b. USG Corporation; USG Sheetrock Brand Tuff-Hide Primer-Surfer: www.usg.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- E. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

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- F. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
- C. Studs: Space studs at 16 inches on center (at 406 mm on center).
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete and concrete walls scheduled to receive gypsum board, not more than 4 inches (100 mm) 4 inches (100 mm) from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches (600 mm) 24 inches (600 mm) on center.
 - 1. Orientation: Horizontal.
 - 2. Spacing: At 16 inches on center (At 400 mm on center).
- F. Resilient Sound Isolation Clips: Install resilient sound isolation clips, and where applicable, associated furring sections and channels, in accordance with clip manufacturer's written instructions.
- G. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall-mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall-mounted door hardware.
 - 7. Handrails and grab bars
 - 8. Wall brackets
 - 9. Display cases, bulletin boards, tack and markerboards.
 - 10. Monitor mounts.

3.03 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

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- C. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically vertically, with edges butted tight and ends occurring over firm bearing.
 - 1. Seal joints, cut edges, and holes with water-resistant sealant.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 - 4. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
 - 5. Horizontal Installation: Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud
 - 6. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
 - 7. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
- D. Installation on Metal Framing: Use screws for attachment of gypsum board.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.05 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use fiberglass joint tape, embed with setting type joint compound and finish with setting type joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls to receive custom wallcovering graphics, and the following spaces:
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
 - 2. Taping, filling, and sanding are not required at base layer of double-layer applications.
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.
- F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.06 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.07 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 092116

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SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.
- C. Accessories

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Acoustical sealant.
- B. Section 211300 - Fire-Suppression Sprinkler Systems: Sprinkler heads in ceiling system.
- C. Section 233700 - Air Outlets and Inlets: Air diffusion devices in ceiling.
- D. Section 265100 - Interior Lighting: Light fixtures in ceiling system.
- E. Section 275116 - Public Address Systems: Speakers in ceiling system.
- F. Section 284600 - Fire Detection and Alarm: Fire alarm components in ceiling system.

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2013a.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2013.
- C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2014.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.
- E. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on other related components, other related components, and other related components.
- C. Samples: Submit two samples 12 x 12 inch (305 x 305 mm) or of size illustrating material and finish of acoustical units.
- D. Samples: Submit two samples each, 6 inches (____ mm) long, of suspension system related sections.
- E. Manufacturer's Installation Instructions: Indicate related work.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: 100 sq ft (____ sq m) of each type and size.

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1.06 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.08 PROJECT CONDITIONS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Install acoustical units after interior wet work is dry.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrong.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. USG: www.usg.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Suspension Systems:
 - 1. Same as for acoustical units.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels Type 1: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
 - 1. Size: 24 by 24 inches (600 by 600 mm).
 - 2. Thickness: 3/4 inches (19 mm).
 - 3. Composition: Wet formed.
 - 4. NRC Range: .70 to .75, determined as specified in ASTM E 1264.
 - 5. Ceiling Attenuation Class (CAC): 35, determined as specified in ASTM E1264.
 - 6. Edge: Square.
 - 7. Surface Color: White.
 - 8. Suspension System: Exposed grid Type 1.
 - 9. Products:
 - a. USG - Radar ClimaPlus High NRC/CAC Item No. 22521.
 - b. Armstrong Fine Fissured 1713.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 10. Suspension System: Exposed grid Type 1.
 - 11. Location: Classrooms and Offices- typical, unless otherwise noted
- C. Acoustical Panels Type 2: Painted mineral fiber, ASTM E 1264 Type 1 ASTM E1264 Type IV, with the following characteristics:
 - 1. Size: 24 by 24 inches (600 by 600 mm).
 - 2. Thickness: 3/4 inches (19 mm).

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3. Composition: Wet formed.
 4. NRC Range: .50 to .60, determined as specified in ASTM E1264.
 5. Ceiling Attenuation Class (CAC): 33, determined as specified in ASTM E1264.
 6. Edge: Square.
 7. Surface Color: White.
 8. Surface Pattern: coarse texture.
 9. Product:
 - a. Armstrong Armatuff 861.
 - b. USG Rock Face ClimaPlus 56335.
 10. Suspension System: Exposed grid Type 2.
 11. Location: Toilet Rooms, other areas as noted.
- D. Glass Fiber Acoustical Panels Type 3: Painted mineral fiber, ASTM E 1264 Type 1 ASTM E1264 Type XII, with the following characteristics:
1. Size: 24 by 24 inches (600 by 600 mm).
 2. Thickness: 7/8 inches (____ mm).
 3. Composition: Wet formed.
 4. NRC Range: .80 to .85, determined as specified in ASTM E1264.
 5. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
 6. Edge: Square.
 7. Surface Color: White.
 8. Surface Pattern: fine texture.
 9. Product:
 - a. Armstrong : Health Zone Ultima High NRC, Item No 1445
 - b. USG: Mars ClimaPlus Healthcare, Item No. 86152
 10. Suspension System: Exposed grid Type 2.
 11. Location: Kitchen, and as noted.
- 2.03 SUSPENSION SYSTEM(S) AND PERIMETER TRIM
- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- B. Exposed Steel Suspension System Type 1: Formed galvanized steel, commercial quality cold rolled; intermediate-duty.
1. Profile: Tee; 15/16 inch (24 mm) wide face.
 2. Construction: Double web.
 3. Finish: White painted.
 4. Products:
 - a. DX by USG
 - b. Prelude XL; Armstrong
 - c. EZ Stab Classic; Certainteed
- C. Exposed Steel Suspension System Type 2: Where this designation is indicated, provide acoustical panel ceiling suspension system complying with the following:
1. Products:
 - a. ZXLA; USG
 - b. Prelude Plus; Armstrong
 - c. EZ Stab Classic Environmental Aluminum Capped; Certainteed
 2. Wide-Face, Capped, Double-Web, Hot-Dip Galvanized-Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, with pre-finished, 15/16-inch-

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(24-mm-) wide, aluminum caps on flanges; other characteristics as follows:

- a. Aluminum Cap Finish: Painted white.

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12-gage 0.08 inch (2 mm) galvanized steel wire.
- C. Perimeter Moldings: Same material and finish as grid.
 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- D. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
 1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and the following requirements:
 - a. Product is 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.
 2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acoustical Sealant for Exposed and Concealed Joints:
 - 1) PL Acoustical Sealant; Chemrex, Inc., Contech Brands.
 - 2) AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
 - 3) SHEETROCK Acoustical Sealant; United States Gypsum Co.
- E. Touch-up Paint: Type and color to match acoustical and grid units.
- F. Fiberglass Edge Sealant: For re-sealing cut fiberglass edges.
- G. Stabilizer bars: for plank acoustical tile installations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M and ASTM E580/E580M and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected ceiling plans.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

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- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.
- J. 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 mm in 3.6 m). Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- K. Form expansion joints . Form to accommodate plus or minus 1 inch (25 mm) movement. Maintain visual closure.
- L. 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, counter splaying, 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. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 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; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, powder-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
 - 6. Do not attach hangers to steel deck tabs.
 - 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 8. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8 inches (200 mm) from ends of each member.
- M. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- N. Install special brake-metal shapes at window heads so that they are square and finished to provide a precise fit. Do not use exposed fasteners.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.

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- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units with pattern parallel to longest room axis.
- D. Fit border trim neatly against abutting surfaces.
- E. Install units after above-ceiling work is complete.
- F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- G. Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
 - 3. Double cut and field paint exposed reveal edges.
- H. Where round obstructions, other similar conditions, bullnose concrete block corners, other similar conditions, and other similar conditions occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 095100

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SECTION 099123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints and stains.
- C. Materials for backpriming woodwork.
- D. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Prime surfaces to receive wall coverings.
 - 4. Prime surfaces to be concealed behind permanently installed fixtures, equipment, and furnishings, prior to installation of the permanent item.
 - 5. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts and convactor and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers, grilles, and convactor and baseboard cabinets to match face panels.
- E. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
 - 6. Floors, unless specifically indicated.
 - 7. Ceramic and other tiles.
 - 8. Brick, architectural concrete, and cast stone.
 - 9. Glass.
 - 10. Acoustical materials, unless specifically indicated.
 - 11. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 055000 - Metal Fabrications: Shop-primed items.
- C. Section 055100 - Metal Stairs: Shop-primed items.
- D. Section 099113 - Exterior Painting.

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1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2005 (Reapproved 2012).
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.
- D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition, www.paintinfo.com.
- E. SSPC-SP 1 - Solvent Cleaning; 2015.
- F. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).
- G. SSPC-SP 6 - Commercial Blast Cleaning; 2007.
- H. SSPC-SP 13 - Surface Preparation of Concrete; (Reaffirmed 2015).; 2003.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified paint system products to be used in project; include description of each system.
- C. Samples: Submit one paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
- D. Manufacturer's Instructions: Indicate special surface preparation procedures.
- E. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gallon (4 L) of each color; store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum five years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five years documented experience.

1.06 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.
- B. Provide sample resident room, illustrating paint colors, textures, and finishes.
- C. Locate where directed by Architect.
- D. Mock-up may remain as part of the work.

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1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F (10 degrees C) for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 fc (860 lux) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Provide paints and finishes from the same manufacturer to the greatest extent possible.
 - 1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
- C. Paints:
 - 1. Benjamin Moore & Co: www.benjaminmoore.com.
 - 2. Glidden Professional, a product of PPG Architectural Coatings: www.gliddenprofessional.com.
 - 3. PPG Paints: www.ppgpaints.com/#sle.
 - 4. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- D. Primer Sealers: Same manufacturer as top coats.
- E. Substitutions: See Section 016000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.

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4. Supply each paint material in quantity required to complete entire project's work from a single production run.
5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:
 - 1) Opaque, Flat: 50 g/L, maximum.
 - 2) Opaque, Nonflat: 150 g/L, maximum.
 - 3) Opaque, High Gloss: 250 g/L, maximum.
 - 4) Varnishes: 350 g/L, maximum.
 - c. Architectural coatings VOC limits of the State in which the Project is located.
 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Colors: As indicated on drawings.
 1. Extend colors to surface edges; colors may change at any edge as directed by Architect.
 2. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.

2.03 PAINT SYSTEMS - INTERIOR

- A. Provide Premium Grade systems (2 top coats) as defined in MPI Architectural Painting Specification Manual, except as otherwise indicated.
- B. SYSTEM I-1:
 1. Substrate: Concrete Masonry Units
 2. Applications include, but are not limited to: Concrete Masonry Units in spaces scheduled to be painted.
 3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat:S-W PrepRite® Block Filler, B25W25
 - 2) 2nd Coat:S-W ProMar® 200 Latex Semi-Gloss, B20W2200 Series
 - 3) 3rd Coat:S-W ProMar® 200 Latex Semi-Gloss, B20W2200 Series
 - b. Benjamin Moore:
 - 1) 1st Coat: Ultra Spec Masonry Interior/Exterior Hi-Build Block Filler 571
 - 2) 2nd Coat: Ultra Spec 500 Interior Latex Semi-Gloss T546
 - 3) 3rd Coat: Ultra Spec 500 Interior Latex Semi-Gloss T546
 - c. Glidden Professional:
 - 1) 1st Coat:Glidden Professional Block Filler 3010 primer
 - 2) 2nd Coat:Glidden Professional Diamond 450 7400 topcoat
 - 3) 3rd Coat:Glidden Professional Diamond 450 7400 topcoat.
 - d. PPG:
 - 1) 1st Coat: PPG Speedhide Int./Ext. Masonry Hi Fill Latex Block Filler 6-15XI.
 - 2) 2nd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.
 - 3) 3rd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.

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C. SYSTEM I-2

1. Substrate: Concrete Masonry Units (Epoxy paint, Semi-gloss finish)
2. Applications include, but are not limited to: Concrete Masonry Units in spaces scheduled to receive epoxy paint.
3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat:S-W Heavy Duty Block Filler, B42W46
 - 2) 2nd Coat:S-W Pro Industrial Waterbased Catalyzed Epoxy, B73-300 Series
 - 3) 3rd Coat:S-W Pro Industrial Waterbased Catalyzed Epoxy, B73-300 Series
 - b. Benjamin Moore:
 - 1) 1st Coat: Corotech Waterborne Epoxy Block Filler V163
 - 2) 2nd Coat: Corotech Waterborne Amine Epoxy V440
 - 3) 3rd Coat: Corotech Waterborne Amine Epoxy V440
 - c. Glidden Professional:
 - 1) 1st Coat:Tru-Glaze 4015 Block Filler
 - 2) 2nd Coat:Tru-Glaze WB 4426 Water-Based Epoxy
 - 3) 3rd Coat:Tru-Glaze WB 4426 Water-Based Epoxy
 - d. PPG:
 - 1) 1st Coat: PPG Speedhide Int./Ext. Masonry Hi Fill Latex Block Filler 6-15XI.
 - 2) 2nd Coat: PPG Aquapon WB EP Water-Based Epoxy 98E-1 Series.
 - 3) 3rd Coat: PPG Aquapon WB EP Water-Based Epoxy 98E-1 Series.

D. SYSTEM I-3: Not Used.

E. SYSTEM I-4

1. Substrate: Structural Steel and Metal Fabrications:
2. Applications include, but are not limited to: steel and metal fabrications, piping, hollow metal doors and frames in spaces scheduled to be painted.
3. Finish: Semi Gloss.
4. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat: DTM Acrylic Primer/Finish, B66W1
 - 2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series.
 - 3) 3rd Coat: S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series.
 - b. Benjamin Moore:
 - 1) 1st Coat: Ultra Spec HP Acrylic Metal Primer HP04
 - 2) 2nd Coat: Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP29
 - 3) 3rd Coat: Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP29
 - c. PPG:
 - 1) 1st Coat: PPG Pitt-Tech Plus Direct to Metal Primer & Flat Finish 4020PF.
 - 2) 2nd Coat: PPG Pitt-Tech Plus EP DTM Acrylic Semi-Gloss 90-1610 Series.
 - 3) 3rd Coat: PPG Pitt-Tech Plus EP DTM Acrylic Semi-Gloss 90-1610 Series.

F. SYSTEM I-5

1. Substrate: Galvanized Metal, Not Chromate Passivated:
2. Applications include, but are not limited to, galvanized metal fabrications, ductwork, conduit, and decking, in spaces scheduled to be painted.
3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat:S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series
 - 2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series.
 - 3) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series.

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- b. Benjamin Moore:
 - 1) 1st Coat: Moore Ultra Spec HP Acrylic Metal Primer HP04
 - 2) 2nd Coat: Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP29
 - 3) 3rd Coat: Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP29
 - c. PPG:
 - 1) 1st Coat: PPG Pitt-Tech Plus Direct to Metal Primer & Flat Finish 4020PF.
 - 2) 2nd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.
 - 3) 3rd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.
- G. SYSTEM I-6
 - 1. Substrate: Woodwork (Opaque Semi-Gloss Finish)
 - 2. Applications include, but are not limited to, finish carpentry items indicated to receive an opaque finish.
 - 3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat: S-W Premium Wall & Wood Primer, B28W8111
 - 2) 2nd Coat: S-W Pro Industrial Acrylic, B66-650 Series
 - 3) 3rd Coat: S-W Pro Industrial Acrylic, B66-650 Series
 - b. Benjamin Moore:
 - 1) 1st Coat: Moore Ultra Spec 500 Interior Latex Primer N534
 - 2) 2nd Coat: Ultra Spec 500 Interior Latex Semi-Gloss T546
 - 3) 3rd Coat: Ultra Spec 500 Interior Latex Semi-Gloss T546
 - c. Glidden Professional:
 - 1) 1st Coat: Glidden Professional High Hide 1000 primer
 - 2) 2nd Coat: Glidden Professional Diamond 450 7400 topcoat
 - 3) 3rd Coat: Glidden Professional Diamond 450 7400 topcoat
 - d. PPG:
 - 1) 1st Coat: PPG Seal Grip Interior Primer/Finish 17-951.
 - 2) 2nd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.
 - 3) 3rd Coat: PPG Speedhide Zero Interior Latex Paint Semi-Gloss 6-5510 Series.
- H. SYSTEM I-7: Not Used.
- I. SYSTEM I-8: Not Used.
- J. SYSTEM I-9: Not Used.
- K. SYSTEM I-10
 - 1. Substrate: Gypsum Board (Satin Finish):
 - 2. Applications include but are not limited to walls, ceilings, soffits, and bulkheads, in spaces scheduled to be painted.
 - 3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat: S-W PrepRite 200 Int. Latex Primer, B28 Series
 - 2) 2nd Coat: S-W ProMar® 200 Latex Eggshell, B20 Series
 - 3) 3rd Coat: S-W ProMar® 200 Latex Eggshell, B20 Series
 - b. Benjamin Moore:
 - 1) 1st Coat: Ultra Spec 500 Interior Latex Primer N534
 - 2) 2nd Coat: Ultra Spec 500 Interior Latex Eggshell T538
 - 3) 3rd Coat: Ultra Spec 500 Interior Latex Eggshell T538
 - c. Glidden Professional:
 - 1) 1st Coat: Glidden Professional High Hide 1000 primer
 - 2) 2nd Coat: Glidden Professional Diamond 450 7300 topcoat

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- 3) 3rd Coat: Glidden Professional Diamond 450 7300 topcoat
- d. PPG:
 - 1) 1st Coat: PPG Speedhide zero Interior Zero-VOC Latex Sealer 6-4900XI.
 - 2) 2nd Coat: PPG Speedhide Zero Interior Latex Paint Eggshell 6-5310 Series.
 - 3) 3rd Coat: PPG Speedhide Zero Interior Latex Paint Eggshell 6-5310 Series.
- L. SYSTEM I-11
 - 1. Substrate: Gypsum Board (Epoxy Finish):
 - 2. Applications include but are not limited to walls, ceilings, soffits, and bulkheads, in spaces scheduled to receive an epoxy paint finish.
 - 3. Manufacturers and Products:
 - a. Sherwin Williams:
 - 1) 1st Coat: PrepRite 200 Int Latex Primer
 - 2) 2nd Coat: ProIndustrial Precat. WB Epoxy, S-G, Series K46
 - 3) 3rd Coat: ProIndustrial Precat. WB Epoxy, S-G, Series K46
 - b. Benjamin Moore:
 - 1) 1st Coat: Ultra Spec 500 Interior Latex Primer N534
 - 2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342
 - 3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342
 - c. Glidden Professional:
 - 1) 1st Coat: Glidden Professional High Hide 1000 primer
 - 2) 2nd Coat: Devoe Coatings TRU-GLAZE WB Epoxy 4426 topcoat
 - 3) 3rd Coat: Devoe Coatings TRU-GLAZE WB Epoxy 4426 topcoat
 - d. PPG:
 - 1) 1st Coat: PPG Speedhide zero Interior Zero-VOC Latex Sealer 6-4900XI.
 - 2) 2nd Coat: PPG PITT-GLAZE WB1 Interior Eggshell Pre-Catalyzed Water-Borne Acrylic Epoxy 16-1310.
 - 3) 3rd Coat: PPG PITT-GLAZE WB1 Interior Eggshell Pre-Catalyzed Water-Borne Acrylic Epoxy 16-1310.
- M. SYSTEM I-12
 - 1. Substrate: Concrete Floor (Sealed):
 - 2. Manufacturers and Products:
 - a. W. R. Meadows:
 - 1) 1st Coat: VOCCOMP-30 Concrete Curing and Sealing Compound
 - b. PPG:
 - 1) 1st Coat: Perma-Crete Plex-Seal WB Interior/Exterior Clear Sealer 4-6200XI.
- N. SYSTEM I-13
 - 1. Chroma Key Finish
 - 2. Manufacturer and product:
 - a. Rosco Laboratories Inc., 52 Harbor View, Stamford, CT, USA, 06902
 - 1) 1st Coat: Rosco Tough Prime
 - 2) 2nd Coat: #05711 Chroma Key Green
 - 3) 3rd Coat: #05711 Chroma Key Green
 - b. Over new gypsum board, apply preliminary coat of primer, then 1st Coat noted above.
 - 1) Preliminary Coat: S-W PrepRite 200 Int. Latex Primer, B28 Series

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

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- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 2. Clean concrete according to ASTM D4258. Allow to dry.
 - 3. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- G. Masonry:
 - 1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 - 2. Prepare surface as recommended by top coat manufacturer.
- H. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- I. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- J. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- K. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.

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2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.
- L. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- M. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Do not apply finishes over dirt, rust, scale, grease, moisture, scuffed surfaces, or other conditions detrimental to formation of a durable coating film; do not apply finishes to surfaces that are not dry.
- D. Use applicators and methods best suited for substrate and type of material being applied and according to manufacturer's instructions.
 1. Brush Application: Use brushes best suited for the type of material applied; use brush of appropriate size for the surface or item being painted; produce results free of visible brush marks.
 2. Roller Application: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Application: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- E. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate; provide total dry film thickness of entire system as recommended by manufacturer.
 1. Number of coats and film thickness required are the same regardless of application method.
 2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance.
 3. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.
- F. Apply finish to completely cover surfaces with uniform appearance without brush marks, runs, sags, laps, ropiness, holidays, spotting, cloudiness, or other surface imperfections.
 1. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
 2. Before applying finish coats, apply a prime coat of material recommended by manufacturer, unless the surface has been prime coated by others; where evidence of suction spots or unsealed areas in first coat appear, recoat primed and sealed surfaces to ensure finish coat with no burn through or other defects due to insufficient sealing.
 3. Apply first coat to surface that has been cleaned, pretreated, or otherwise prepared as soon as practical after preparation and before subsequent surface deterioration.
 4. Do not apply succeeding coats until the previous coat has cured as recommended by manufacturer.

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5. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat will not cause the undercoat to lift or lose adhesion.
 6. If manufacturer's instructions recommend sanding to produce a smooth, even surface, sand between coats.
 7. Before applying next coat vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
 8. Pigmented (Opaque) Finishes: Provide smooth, opaque surface of uniform finish, color, appearance, and coverage.
- G. Metal Doors to be Painted: Finish metal door top, side, and bottom edge surfaces same as face of door.
- H. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- I. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- J. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- K. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- L. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- M. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- 3.04 CLEANING
- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- 3.05 PROTECTION
- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099123

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DIVISION 21 SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE PROTECTION
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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE PROTECTION

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.
- 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. Modify sprinkler piping, sprinkler head locations, and extend fire protection system as required to accommodate wall changes, ceiling changes, new bulkheads, and M/E/P changes. Hydraulically calculate all pipe sizes based on NFPA-13.
- I. The existing fire protection system shall remain unless otherwise noted. Re-located fire protection piping, hangers, valves, sprinkler heads, and fire alarm wiring as required to accommodate demolition and new work as shown on the Contract Documents. Install new heads, piping, and hangers as required.
- J. Existing fire protection system, piping, sprinkler heads, and fittings shall be modified to accommodate demolition and installation of new systems.
- K. Provide new sprinkler heads where new ceilings and bulkheads are provided. Extend sprinkler piping to coordinate with new ceiling heights, bulkheads, and ductwork, piping and equipment installation. Refer to architectural reflected ceiling plans.
- L. Fire protection contractor shall survey existing fire suppression system and submit

hydraulic drawings and calculations to State Fire Marshal for review and approval.

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. Existing items of equipment are being relocated 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.

1.6. 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 three (3) 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. Coordinated Drawings
 - 3. Drip Pans
 - 4. Exterior Equipment/Piping Supports
 - 5. Fire Protection System including Hydraulic Calculations, Equipment and Devices
 - 6. Fire Stopping - Methods and Materials
 - 7. Identification System
 - 8. Material and Equipment List
 - 9. Operations and Maintenance Manuals
 - 10. Pipe Materials Including Itemized Schedule
 - 11. Preliminary and Final Pipe Pressure Tests
 - 12. Pressure Gauges
 - 13. Sprinkler Heads
 - 14. Strainers
 - 15. Test Certificates
 - 16. Valves
 - 17. Vibration Isolation Materials

- 18. Weatherproof Assembly Components
- 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.

1.11. CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 21. 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.

1.12. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. Unless otherwise noted on the drawings, where existing fire protection work is removed, pipes, valves, etc., shall be 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 21 connects to existing equipment and piping, 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 21, or under other Divisions, requires relocation of existing equipment, piping, 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.
- E. Fire suppression system will remain active throughout the duration of the project. Contractor shall provide temporary wire baskets to protect sprinkler heads during construction. Include all provisions for fire watch as determined by the Fire Marshal.

1.13. DEMOLITION

- A. Unless otherwise noted all existing equipment, piping, etc., shall remain.
- B. Where existing equipment is indicated to be removed, all associated piping, conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc. Patch, paint and repair walls/roof/floor to match existing and/or new finishes.
- C. Provide necessary piping, valves, temporary feeds, etc., as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time lengths of outages.
- D. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.
- E. Where any abandoned pipes in existing floors, walls, ceilings, etc., conflict with new work, remove abandoned pipes as necessary to accommodate new work.
- F. The location of all existing equipment, piping, etc., indicated is approximate only and shall be checked and verified. Install all new fire protection work to connect to or clear existing work as applicable.

- G. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the authorities having jurisdiction.
- H. Make provisions and include in bid all costs associated with confined entry/space requirements.
- I. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing piping systems to new piping systems with the appropriate shut-off valves and tamper switches.
- J. At completion of project all temporary piping, valves, controls, etc., shall be removed in their entirety.
- K. Existing piping, equipment, materials, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- L. 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.
- M. 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.
- N. Where piping is removed, remove all pipe hangers which were supporting the removed piping. Patch the remaining penetration voids with like materials and paint to match existing construction.
- O. 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.
- P. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.
- Q. The Owner shall have the first right of refusal for all devices and equipment removed by the Contractor.
- R. 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.
- S. 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.
- T. Work Abandoned in Place: cut and remove underground pipe a minimum of 2 inches

beyond face of adjacent construction. Cap and patch surface to match existing finish.

- U. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- V. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.
- W. After demolition of ceilings install aluminum inverted pie plates above each sprinkler head. Maintain throughout construction phase. Remove with the installation of new ceilings.

1.14. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.15. 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, and unexcavated spaces.
- 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.

1.16. 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.
- J. Where equipment under this Division is specified with integral disconnecting means, the same shall be a single disconnecting means for disconnecting all ungrounded main power supply conductors that is capable of being locked in the open ("off") position in accordance with the National Electrical Code and the local electrical inspector.

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.

2.3. ENCLOSURES

- A. Electrical enclosures including factory provided enclosures, field provided and installed enclosures, and automatic temperature control system enclosures shall be as follows:
 - 1. Dry Interior Locations: NEMA 1.
 - 2. Damp/Wet Locations, Including Exterior Locations: NEMA 3R.
 - 3. Corrosive Locations, Including Laboratories, Chemical Storage Rooms, Janitor's Closets, and Similar Space = NEMA 4X.

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 stainless steel including 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 minimum of 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 20 inches x 30 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, kitchens, dishwasher 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 in Division 09 and conform to ANSI Standards.
 - 1. Interior wet-applied paints, and coatings: Comply with low-emitting requirements in Division 01 Section "Sustainable Design Requirements – LEED".
- 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.
- I. Refer to Division 09 for additional painting requirements.

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-up 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 three (3) hard copies and one (1) electronic copy 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 Suppression System 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 four (4) 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, 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.
- G. For renovation projects where new pipes penetrate existing floors, furnish ground penetrating radar to properly map out acceptable locations for pipe penetrations. Review penetrations with Structural Engineer.

3.12. RECORD DRAWINGS

- A. Upon completion of the mechanical installations, the Contractor shall deliver to the Engineer 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 Engineer.

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 (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.

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 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. OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared three (3) 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 – Caesar Rodney School District – Magnolia Middle School – HAC Renovations – 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. Electronic copies of the manual shall be saved on USB flash drives, and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of Volume 1 (if applicable) of hard copies of the manual.
- D. 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 Suppression System Certificates.
 11. Start-up reports for equipment.
 12. NFPA Test Reports.
- E. Electronic copies of the manual shall be saved on USB flash drives, and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of volume 1 (if applicable) of hard copies of the manual.
- F. 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.

3.16. 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 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 twenty-four (24) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Fire Suppression Piping (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.

3.18. PHASING

- A. Refer to Specifications and contract drawings for any required phasing.
- B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner, and Authorities having jurisdiction.
- C. Provide dust barriers/partitions, penetration closures, etc., to ensure safety of building occupants and protection of existing surroundings.
- D. The Building shall remain watertight at all times.
- E. Refer to phasing plans for additional requirements.
- F. Provide necessary piping, valves, etc. as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time length of outages. Temporarily feed new systems with existing system where required.
- G. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the facility and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.
- H. Due to phased construction, some systems must be operated until later phases are completed.
- I. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.
- J. After demolition of ceilings install aluminum inverted pie plates above each sprinkler head (as heat trap). Maintain throughout construction phase. Remove with the installation of new ceilings. Submit to Fire Marshall for review and approval.

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.

HVAC RENOVATIONS
SRS2503

CAESAR RODNEY SCHOOL DISTRICT
MAGNOLIA MIDDLE SCHOOL

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: _____

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DIVISION 21 SECTION 21 05 05
FIRE SUPPRESSION SYSTEM PIPING, FITTINGS & VALVES
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SECTION 21 05 05 - FIRE SUPPRESSION SYSTEM PIPING, FITTINGS & 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. 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 Suppression System Piping (NFPA-13):
 - a. 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.
 - b. Piping Above Grade (Outside): Galvanized Steel
 - c. 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.
 - d. Dry Pipe Fittings: UL listed for dry pipe service.
 - 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").
 - 2) 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.
- 1) 2" through 8": "Installation Ready" stab-on flexible coupling, designed for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic QuickVic Style 177.
 - 2) 2" and Larger: Standard flexible coupling design. Victaulic Style 75 or 77.

Fire Suppression System 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: 2-1/2 inches 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 suppression 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 suppression 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.

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 $\frac{3}{4}$ -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
$\frac{3}{4}$ & 1	6	5	$\frac{3}{8}$
1 - $\frac{1}{2}$	6	8	$\frac{3}{8}$
2	8	8	$\frac{3}{8}$
2 - $\frac{1}{2}$	10	9	$\frac{1}{2}$
3	12	10	$\frac{1}{2}$
4	14	12	$\frac{5}{8}$
5	14	12	$\frac{5}{8}$
6	16	14	$\frac{3}{4}$
8	18	16	$\frac{7}{8}$
10	20	18	$\frac{7}{8}$
12	20	18	$\frac{7}{8}$

- 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.
- P. For Pipe Hangers installed in corrosive environments such as the chemical storage rooms, Janitor's Closets...etc. the same shall be finished with an Electro-Galvanized finish such as Galv-Krom® or approved equal.

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: 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 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.

2.5. 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, and connections to air compressors, all vibrating equipment and elsewhere as shown. Refer to Division 23 Section, Vibration Control for HVAC, Plumbing and Fire Protection Equipment for specifications.
- B. Victaulic Style 177, 75, or 77, Grinnell, or approved equal, flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.

2.6. 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.

2.7. 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.

2.8. 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 $\frac{3}{4}$ -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.

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 or devices and 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 combustion air dampers and 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 pressure gauges 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 fine 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.
- M. Fire protection pipes shall be supported independently of other building trade supports per NFPA-13.

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 NFPA pamphlets, 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)
$\frac{1}{2}$ to 1 $\frac{1}{4}$	8	$\frac{1}{2}$
1- $\frac{1}{2}$ to 2	8	$\frac{3}{4}$
2 $\frac{1}{2}$ to 6	12	1 $\frac{1}{4}$
8 to 10	24	2 $\frac{1}{2}$
Over 10	32	3 $\frac{1}{2}$

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 three (3) 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

DIVISION 21 SECTION 21 10 03
WATER BASED FIRE SUPPRESSION SYSTEM
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SECTION 21 10 03 - WATER BASED FIRE SUPPRESSION SYSTEM

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. Pressure Sensing Devices, Valves
 - 2. Pressure/Vacuum Gauges
 - 3. Inspector's Test Station
 - 4. Eccentric Reducers
 - 5. Pressure Switches
 - 6. Valves and Piping
 - 7. Flow Switches
 - 8. Tamper Switches
 - 9. Auxiliary Drains
- 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-14, 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, No. 14, 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, County 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 =	73 psig
Residual Pressure =	50 psig
Flow =	802 gpm
Location =	Back of school.
Size of Mains =	8 inches
Existing Pipe Material	For Hydraulic Calculations Assume Roughness Coefficient C factor = 100 for all Exterior Piping.

- H. Hydraulic calculations shall include a 10 psig safety factor to account for pipe aging and deterioration of water supply.
- I. Where combustible construction materials are located above ceilings, provide above ceiling fire protection in accordance with N.F.P.A-13.

- J. Where the architectural documents indicate ceiling “clouds” provide sprinklers above and below the same per NFPA-13. Coordinate exact locations of sprinkler heads and piping with Architect. Submit to Architect for review/approval sprinkler head/piping layout in these areas prior to submitting to working drawings.

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 Suppression System 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. 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.
- F. 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 and NFPA-14, but not indicated on contract drawings. Coordinate with the alarm system and electrical subcontractor.
- G. Pipe and fittings shall meet the requirements of NFPA 13, NFPA-14, and NFPA-24.
- H. Wet pipe alarm check valve shall be Victaulic FireLock Series 750, Reliable Automatic Sprinkler Co., Tyco Fire Products, 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.
- I. 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.

- J. Water motor alarm shall be Victaulic Series 760, Globe Fire Sprinkler Corp., Tyco Fire Products, Viking Corp., or approved equal. 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.

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. The temperature rating of the sprinklers shall be as required by N.F.P.A.-13 and or the authority having jurisdiction.

E. 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.

F. Provide extended escutcheons in rooms with surface mounted lighting fixtures.

G. 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.

- H. Head guards shall be provided in mechanical spaces, penthouses, janitors' closets, electrical rooms, storage areas, gymnasiums. Finish for head guards in finished spaces shall be selected by Architect.
- I. Sprinkler escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.
- J. Provide high temperature sprinkler heads for use adjacent to kilns, skylights, autoclaves, heaters, lights, or other high temperature areas.
- K. All sprinklers, piping, and pipe hangers installed in corrosive areas (chemical room, janitor's closets...etc.) shall be provided with a protective coating.

2.3. FLEXIBLE SPRINKLER DROPS

- A. Stainless Steel Sprinkler Fittings
 - 1. Manufacturer: Victaulic AquaFlex® or Grinnel.
 - 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, Reliable Automatic Sprinkler Co., Tyco Fire Products, Victaulic, 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.

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. 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, Reliable Automatic Sprinkler Co., Tyco Fire Products, or approved equal.

2.9. VALVES

- A. Provide and install control valves as indicated on contract drawings and as required by N.F.P.A.-13, and N.F.P.A.-14. 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.

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 detector check valve assembly at sprinkler system water source connection.
- D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent fire department connections 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. 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.
- T. Refer to Architectural Drawings for exact location and extent of all fire rated walls and smoke barriers.
- U. 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. Where required by NFPA-13 and/or the authority having jurisdiction, install sprinkler heads above and below ceilings.

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, 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. Provide permanent identification signs indicating portion of system controlled by each valve.
- B. 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 sprinklers.
- B. Connect piping to specialty valves, specialties, fire department connections, and accessories.
- C. 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. Fill wet-pipe sprinkler piping with water.
- G. Energize circuits to electrical equipment and devices.
- H. Adjust operating controls and pressure settings.
- I. 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, NFPA Standard No. 14, and NFPA Standard No. 25. Test certificate shall be forwarded to the Office of the State 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, 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 four (4) 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

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DIVISION 22 SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING
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END OF SECTION 21

SECTION 22 05 00 - 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. Existing items of equipment are being relocated 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.

1.6. 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. DNREC - Delaware Department of Natural Resources and Environmental Control
- K. FM - Factory Mutual
- L. IBC - International Building Code
- M. IEEE - Institute of Electrical and Electronics Engineers
- N. MSSP Industry - Manufacturers Standards Society of the Valve and Fittings Industry
- O. NEC - National Electrical Code
- P. NEMA - National Electrical Manufacturers Association
- Q. NSF - National Sanitation Foundation
- R. UL - Underwriters' Laboratories
- S. 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 three (3) 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. Automatic Temperature Control System and Equipment as it relates to plumbing system
 - 3. Backflow Preventers
 - 4. Coordinated Drawings
 - 5. Condensate Neutralizers
 - 6. Drain Valves
 - 7. Drip Pans
 - 8. Equipment Rails
 - 9. Exterior Equipment/Piping Supports
 - 10. Exterior Pipe Roller Supports
 - 11. Fire Stopping - Methods and Materials
 - 12. Gas Pressure Regulating Valves
 - 13. Gauges
 - 14. Identification System
 - 15. Makeup Water Meters
 - 16. Material and Equipment List
 - 17. Operations and Maintenance Manuals
 - 18. Pipe Enclosures
 - 19. Pipe Guides and Anchors.

20. Pipe Materials Including Itemized Schedule
 21. Pressure/Temperature Relief Valves
 22. Pressure Regulating Valves
 23. Screenshots of ATC System Graphics
 24. Shock Absorbers
 25. Strainers
 26. Test Certificates
 27. Thermal Insulation Materials Include Table Summary
 28. Thermometers and Gauges
 29. Vacuum Breakers
 30. Valves
 31. Water Meters
 32. Weatherproof Assembly Components
 33. 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.

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 workman-like 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. All work associated with the existing roof shall be performed so as to maintain the existing roof warranty.

1.13. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. Unless otherwise noted on the drawings, where existing plumbing work is removed all pipes, valves, etc., shall be 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 22 connects to existing equipment, piping, 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 22, or under other Divisions, requires relocation of existing equipment, piping, 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. Where existing insulation is disturbed, replace insulation where removed or damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.
- 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.

1.14. DEMOLITION

- A. Unless otherwise noted all existing equipment, piping, etc., shall remain.
- B. Where existing equipment is indicated to be removed, all associated piping, conduit, power, controls, control panels, sensors, tubing, insulation, hangers, supports and housekeeping pads, etc., patch, paint and repair walls/roof/floor to match existing and/or new finishes.
- C. Provide necessary piping, valves, traps, temporary feeds, etc., as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time lengths of outages.
- D. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.
- E. Refer to phasing plans for additional requirements.
- F. Where any abandoned pipes in existing floors, walls, ceilings, etc., conflict with new work, remove abandoned pipes as necessary to accommodate new work.
- G. The location of all existing equipment, piping, etc., indicated is approximate only and shall be checked and verified. Install all new plumbing work to connect to or clear existing work as applicable.
- H. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the authorities having jurisdiction.
- I. When applicable, make provisions and include in bid all costs associated with confined entry/space requirements in applicable spaces and OSHA regulations.
- J. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing piping systems to new piping systems with the appropriate shut-off valves.
- K. At completion of project all temporary piping, valves, controls, etc., shall be removed in their entirety.
- L. Existing piping, equipment, materials, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- M. 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.
- N. 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 refrigerants. Contractor shall include in his bid all cost

associated with the evacuation, removal and disposal of all existing equipment containing refrigerants in accordance with EPA and Health Department requirements.

- O. Where piping is removed, remove all pipe hangers which were supporting the removed piping. Patch the remaining penetration voids with like materials and paint to match existing construction.
- P. 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.
- Q. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.
- R. The Owner shall have the first right of refusal for all plumbing fixtures, devices and equipment removed by the Contractor.
- S. All plumbing fixtures, 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 plumbing fixtures, devices and equipment in a safe manner to prevent damage while stored.
- T. 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.
- U. Work Abandoned in Place: cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- V. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- W. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

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, and unexcavated spaces.
- 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. 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 plumbing devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- D. Department of Energy (DOE) compliance: Pump manufacturers shall comply with US Department of Energy (DOE) energy conservation standard for “clean water pumps” 1-200 horse power, less than 459 feet of head and greater than 25 gpm. These pumps shall be evaluated using the Pump Energy Index (PEI) of equal to or lesser than 1.0. The PEI number shall appear on the pump name plate and available for the record at <http://er.pumps.org>.
- E. Where Energy Star certification exists for equipment utilized on this project, the equipment must be Energy Star certified. Provide Energy Star certification with submittals.

1.18. 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.

1.19. 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.

1.20. COORDINATION WITH CAESAR RODNEY SCHOOL DISTRICT I.T. DEPARTMENT

- A. All equipment that interfaces with the internet shall be coordinated with the Caesar Rodney School District I.T. Department to verify that the same is suitable for use on the Caesar Rodney School District IT infrastructure. Coordinate with the Caesar Rodney School District I.T. Department regarding the allowable frequency bands to avoid interference with the Caesar Rodney School District I.T. infrastructure.

1.21. EXTRA MATERIALS

- A. Provide one set of seals for each type and model of pump provided on the project.

PART 2. ELECTRICAL REQUIREMENTS (NOT USED)

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 Engineer.

- 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.

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 minimum of 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 20 inches x 30 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, Acudor Products, Babcock-Davis, Nystrom, 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, kitchen rooms, kitchens, dishwasher rooms, can wash 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 three (3) 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 four (4) hours of straight time instruction to the operating personnel. This instruction period shall consist of not less than two (2) consecutive 8 hour days. 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 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 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 (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.

3.14. OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared three (3) 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 – Caesar Rodney School District – Magnolia Middle School – HVAC Renovations– 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. Electronic copies of the manual shall be saved on USB flash drives, and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of Volume 1 (if applicable) of hard copies of the manual.
- D. 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.
 - 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 Department, 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.
- E. Electronic copies of the manual shall be saved on USB flash drives, and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of volume 1 (if applicable) of hard copies of the

manual.

- F. 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 are 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 plumbing piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of twenty-four (24) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Domestic Water & Coil Drain Piping	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 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

1 inch. 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.

3.17. 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.

3.18. PHASING

- A. Refer to Specifications and contract drawings for any required phasing.
- B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities having jurisdiction.
- C. Provide dust barriers/partitions, penetration closures, etc., to ensure safety of building occupants and protection of existing surroundings.
- D. The Building shall remain watertight at all times.
- E. Refer to phasing plans for additional requirements.
- F. Provide necessary piping, valves, etc. as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time length of outages. Provide valves, to maintain existing systems in operation until all equipment is connected. Temporarily feed new systems with existing system where required or shown on contract drawings.
- G. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades.

The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the facility and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.

- H. Due to phased construction, some systems must be operated at part load conditions until later phases are completed.
- I. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

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: _____

DIVISION 22 SECTION 22 05 05
PLUMBING PIPING, FITTINGS & VALVES
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SECTION 22 05 05 - 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 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.
- H. 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. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.6. LEAD FREE REQUIREMENTS

- A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State requirements.

1.7. 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. Domestic Cold 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 807N or approved equal. Couplings shall be coated blue enamel.
 - 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.
 - iv. For copper/stainless steel/CPVC pipe the gasket shall be potable water grade P compound with a red and blue stripe color code for operating temperatures from 0°F to 180°F.
 - 1) Reference shall always be made to the latest published Victaulic selection guide for gaskets for proper gasket selection for the intended purpose.
- 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. 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.
- j. (Alternate): At contractor's option, Viega ProPress pressure seal mechanical fittings may be utilized.
 - i. Viega ProPress, Mueller Streamline PRS or approved equal, 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. Pressure Seal fittings 1/2-inch thru 4-inch for use with ASTM B88 copper tube type L and 1/2-inch up to 1-1/4-inch annealed copper tube. Pressure Seal fittings shall have an EPDM sealing element grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) or Sure PS Leak Detection.

2. Gas Piping:

- a. Pipe: Inside Building Above Ground: Schedule 40 uncoated black steel pipe, ASTM A53 or A120.
- b. Outside building above grade/roof: Schedule 40 black steel pipe, ASTM A53 or A120.
- c. Fittings & Joints: 150 lb. screwed malleable iron ASTM B16.3 with joints sealed with litharge and glycerin. Piping 2 1/2 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.

- d. 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.
- e. 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
- f. 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.
- g. 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.
- h. Finish: All gas piping downstream of regulator, installed exposed in a kitchen, or piping installed on a roof 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.

3. 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 F 656 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, 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
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

- 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 1/2 to 1 1/2 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. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.
- G. 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.
- H. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook
- I. Vertical Support: Steel riser clamp.
- J. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- K. Copper pipe support: Carbon steel ring, adjustable, copper plated.
- L. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- M. 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.
- N. For Pipe Hangers installed in corrosive environments such as chemical storage rooms, janitor's closets...etc. the same shall (including hardware) shall be finished with on Electro-Galvanized Finish such as Galv-Krom® or approved equal.

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.

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 type. 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, Honeywell or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.7. 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.

2.8. PIPING SPECIALTIES

- A. 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.

- B. 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. Install stainless steel mesh screen and turndown on all gas relief valve/vent piping terminations.

2.9. 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.

2.10. 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.

2.11. 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 ¾-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.

2.12. 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. Maximum working pressure shall be 300 psig.
- B. Provide pressure gauge adjacent to all pressure reducing valves to verify proper set point.

2.13. 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.

2.14. GAS PRESSURE REGULATORS

- A. Gas pressure regulators shall be as manufactured by Equimeter, Inc., Maxitrol Co., Rockwell, Fisher Controls, American Meter Co., Pietro Fiorentini, 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. Gas pressure regulator shall be a positive lock-up type regulator where required by equipment manufacturer.
- D. 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.
- E. Regulators installed outside the building shall be rated for exterior installation.

2.15. 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 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.
- 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. 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.
- 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. Install all valves with stem upright or horizontal, not inverted.
- O. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.
- P. Provide clearance for installation of insulation and access to valves and fittings.
- Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- R. All water containing pipes shall be routed clear of combustion air dampers and louvers to prevent freezing condition when dampers are open.
- S. Provide manual air vents at top of piping systems.
- T. Where access doors are required, install piping so that valves can be grouped together to minimize the quantity of access doors.
- U. Install manufactured U.L. listed firestop collars at all floor/wall penetrations for all PVC and CPVC pipe penetrations.

3.2. PRESSURE GAGE INSTALLATION REQUIREMENTS.

- A. Install gauges and adjust vertical and tilted positions.
- B. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.
- C. Adjust faces of gages to proper angle for best visibility.
- D. Clean windows of 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. 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 fine 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 1/4-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 and/or NFPA-58.
 - 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.
4. Vent all gas regulator vent pipes per NFPA-54 requirements.
- 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.

3.5. 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. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Victaulic, Grinnells Figure 173/273, Sure-Joint, or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shields shall be Carpenter Patterson, 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 Carpenter Patterson, 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 Carpenter Patterson, 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.

3.6. 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.

3.7. DIRT POCKETS INSTALLATION REQUIREMENTS

- A. Dirt pockets shall be installed at the base of all risers, upstream of gas regulators, and ahead of all gas equipment and as indicated on the drawings.

3.8. EXPANSION LOOPS AND SWING CONNECTION INSTALLATION REQUIREMENTS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to plumbing equipment with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to plumbing equipment with at least four pipe fittings, including tee in main.
- D. Install expansion loops, guides, and anchors on all CPVC domestic water piping as required per manufacturer's instructions.

3.9. 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)
$\frac{1}{2}$ to $1 \frac{1}{4}$	8	$\frac{1}{2}$
$1 \frac{1}{2}$ to 2	8	$\frac{3}{4}$
$2 \frac{1}{2}$ to 6	12	$1 \frac{1}{4}$
8 to 10	24	$2 \frac{1}{2}$
Over 10	32	$3 \frac{1}{2}$

3.10. 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 three (3) 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.

3.11. CLEANING PIPING AND EQUIPMENT REQUIREMENTS

- 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.

3.12. PRESSURE SEAL FITTING INSTALLATION REQUIREMENTS

- A. Viega, ProPress Pressure Seal bronze, Mueller Streamline, or approved equal 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, Mueller Streamline, or approved equal. 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 local code, or specification requirements, not to exceed 600 psi with water or 200 psi when using air fitting.

HVAC RENOVATIONS
SRS2503

CAESAR RODNEY SCHOOL DISTRICT
MAGNOLIA MIDDLE SCHOOL

END OF SECTION

DIVISION 22 SECTION 22 07 01
PLUMBING INSULATION
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SECTION 22 07 01 - 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.

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, Johns Manville, Knauf, or approved equal.
- 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. All disturbed piping insulation in existing areas shall be re-insulated with insulation type, density, and thickness as specified for new piping. Insulation damaged due to new work and demolition only shall be replaced unless otherwise noted.
- H. On cold systems such as domestic cold water, 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.
- 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, grooved joint PVC fitting valve and coupling covers shall be utilized. Grooved joint 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.
- 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 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 Domestic Cold Water Piping	1-inch thickness
All Drain Piping from Cooling Coils/Evaporators	½-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. Backflow Preventer Valve Bodies.
 2. Pressure Reducing Valve Bodies.
 3. Make-up Water Valve Bodies.
 4. Make-Up Water Meters.
- 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. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.
- C. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.
- D. Support rings shall be provided to support the top head insulation where required.
- E. Outdoor installations require a weather barrier mastic for protection of the insulation jacketing.
- F. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

- G. Install removable insulation sections at all cleanouts, test ports, and items that must be periodically tested.

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 band 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, above architectural ceiling clouds, mezzanines, penthouses, boiler rooms, janitor's closets, kitchens, 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

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DIVISION 22 SECTION 22 40 05
PLUMBING EQUIPMENT
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SECTION 22 40 05 - 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, Town of Magnolia 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 A112.26.1 - Water Hammer Arrestors.
- E. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- F. PDI WH-201 Water Hammer Arresters.
- G. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
- H. ASME Section VIII D - Pressure Vessels; Boiler and Pressure Vessel Codes.
- I. ANSI/NFPA 54 - National Fuel Gas Code.
- J. ANSI/NFPA 70 - National Electrical 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. SHOCK ABSORBERS

- A. Provide shock absorbers equal to Josam Shokstops at all fast closing valves, at the top of all cold water risers, 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.

2.2. 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. Provide atmosphere vacuum breakers at all water connections to garbage disposers, hose spray units as required by Plumbing Code.
- D. 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.
- E. 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.
- F. Approved manufacturers: Watts, Beeco, B&K Industries, Zurn, Sparco, Conbraco or approved equal.

2.3. 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.

2.4. DOMESTIC MAKEUP WATER METER

- A. Furnish and install a bronze multi-jet water meter on make-up water to building heating

and cooling systems. The water meter shall be Model WNT as manufactured by Dwyer, Sensus, Badger, Rockwell, ABB, Hersey, or approved equal. Unit shall be sized and selected so as not to exceed the scheduled maximum pressure drop at design flow.

- B. Main cases for all sizes shall be brass. Size, model and direction of flow shall be cast, in raised characters, on both sides of the Main cases.

Operating Characteristics		
Meter Size	Low Flow (95 percent minimum)	Normal Range (100.0 +/- 2 percent)
1-1/2-inch	0.4	0.7 to 70

- C. Meters shall have performance capabilities of continuous operation up to the rated maximum flows as outlined above without affecting long term meter accuracy or causing undue wear. Meters shall also have a 25 percent flow capacity in excess of the maximum flows listed for intermittent flow demands.
- D. The measuring chamber shall be of unitized construction (i.e., complete with measuring element, calibration device and register in one assembly). The measuring chamber shall be capable of operating within above listed accuracy limits without recalibration when transferred from one maincase to another. The measuring element shall be mounted on a horizontal stationary shaft with sleeve bearings and be essentially weightless in water.
- E. The register shall be permanently hermetically sealed; all registers of similar size and registration to have a standard ratio gear reduction so as to permit interchange ability. The register shall be assembled to measuring chamber in a tamper proof manner so removal can be made only after measuring chamber is removed from the maincase. Sweep hand reading and odometer wheel details will conform to American Water Works Standard C-701, as most recently revised. Provide 5 drum register to read gallons.
- F. All meters shall operate without leakage, damage or malfunction up to a maximum operating pressure of 150 pounds per square inch.
- G. Meters of similar design concept must be available for purchase in all of the sizes specified above. The turbine meters must have a minimum of five (5) years of satisfactory operating experience as marketable products. Limited experimental history is not acceptable. The meter manufacturer shall submit, in writing, a price schedule of its factory maintenance program for the measuring chambers.
- H. The water meter shall be fully field insulated and jacketed to prevent condensation.

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. 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.

- D. Coordinate with Architectural Drawings before roughing in plumbing.
- E. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.
- F. See site plan for extent of all piping leaving and entering building.
- G. See domestic water riser diagrams for location of valves, shock absorbers, balance valves, etc.
- H. Make proper CW connections to all equipment even though all branch main, elbows and connections are not shown.
- I. Domestic cold recirculating water piping shall be installed between ceiling and roof insulation.
- J. Unless otherwise noted, all domestic water piping and fire protection piping shall be installed on heated side of ceiling insulation.
- K. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

3.2. 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 where indicated.
- F. Fasten recessed, wall mounting plumbing specialties to reinforcement built into walls.
- G. Secure supplies to supports or substrate.
- H. 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.

- I. Install water supply stop valves in accessible locations.
- J. 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.
- K. Install ball valves at all shock absorbers to allow removal for service/replacement.

3.3. WATER METER INSTALLATION REQUIREMENTS

- A. Install water meters, piping, and specialties according to Manufacturer's requirements.
 - 1. Install displacement type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.
 - 2. Install compound type water meters with shutoff valves on water meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
 - 3. Install detector type water meters with shutoff valves on water meter inlet and outlet and on full size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers. Install roughing in piping and specialties for water meter installation according to utility's instructions and requirements.
- B. Field insulate and jacket water meter to prevent condensation.
- C. Provide spare strainer screen for all water meters with integral strainers.

3.4. TESTING

- A. 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.

3.5. 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.

3.6. 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.

3.7. CLEANING

- A. At completion, clean plumbing equipment.

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DIVISION 23 SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC
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SECTION 23 05 00 - 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. ADC - Air Diffusion Council
- F. AGA - American Gas Association
- G. AMCA - Air Movement and Control Association
- H. ANSI - American National Standards Institute
- I. ARI - Air Conditioning and Refrigeration Institute
- J. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
- K. ASME - American Society of Mechanical Engineers
- L. ASPE - American Society of Plumbing Engineers
- M. ASTM - American Society for Testing and Materials
- N. ASME CSD-1 - American Society of Mechanical Engineers Controls and Safety Devices for Automatically Fired Boilers
- O. CS - Commercial Standard
- P. CSD - Control and Safety Devices
- Q. DNREC - Delaware Department of Natural Resources
- R. FM - Factory Mutual
- S. IBC - International Building Code
- T. IBR - Institute of Boiler and Radiator Manufacturers
- U. IEEE - Institute of Electrical and Electronics Engineers
- V. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry

- W. NEC - National Electrical Code
- X. NEMA - National Electrical Manufacturers Association
- Y. NFPA - National Fire Protection Association
- Z. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
- AA. UL - Underwriters' Laboratories
- BB. State of Delaware Fire Protection Regulations.
- CC. 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 three (3) 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 Chillers
 - 4. Air Distribution Systems
 - 5. Air Separators
 - 6. Antifreeze Fluids
 - 7. Antifreeze Pressure Tanks
 - 8. Automatic Air Vents
 - 9. Automatic Temperature Control Systems and Equipment
 - 10. Automatic Glycol Feed Systems & Pressure Tanks
 - 11. Boiler Accessories, Trim, Flow Switches
 - 12. Boiler Breaching, Stacks, and Combustion Air Ducts

13. Boiler Burners
14. Boilers and Accessories
15. Carbon Dioxide Sensors
16. Carbon Monoxide Detectors
17. Central Control and Monitoring Systems (CCMS) and Equipment
18. Chemical Feed Tank
19. Condensate Neutralizers
20. Condensate Pumps
21. Conventional Hydronic Control Valves
22. Coordinated Drawings
23. Dewpoint Temperature Sensors
24. Differential Bypass Valves, Transmitters
25. Drip Pans
26. Duct Materials
27. Electric Radiant Heat Panels
28. Energy Recovery Ventilators
29. Equipment Rails
30. Expansion Loops
31. Expansion Tanks and Accessories
32. Exterior Equipment/Duct Piping Supports
33. Exterior Pipe Roller Supports
34. Fan Coil Units (Ductless and Ducted)
35. Fans
36. Filters
37. Filter Housings/Mixing Boxes
38. Fire Stopping - Methods and Materials

39. Fire Dampers
40. Flow Measuring Stations
41. Flowmeter and Primary Elements (Flow Fittings)
42. Fluid Filter Housings
43. Glycol Feed Systems
44. Grilles, Registers, Diffusers
45. Heat Pipes
46. Horizontal Hot Water Unit Heaters
47. Identification Systems
48. In-Line Circulators
49. Intake Hoods
50. Louvers and Insulated Blank-Off Panels
51. Material and Equipment Lists
52. Pete's Plugs
53. Pipe Enclosures
54. Pipe Guides and Anchors
55. Pipe Materials Including Itemized Schedules
56. Preliminary Testing and Balancing Reports
57. Pressure Relief Valves
58. Pressure Regulating Valves
59. Pressure Independent Control Valves
60. Pumps
61. Roof Curbs
62. Relief Hoods
63. Schrader Fittings with Ball Valves
64. Screen shots of ATC System Graphics

- 65. Single Zone VAV Units
 - 66. Static Pressure Sensors
 - 67. Strainers
 - 68. Test Certificates
 - 69. Thermal Insulation Materials Include Table Summaries
 - 70. Thermometers and Gauges
 - 71. Unit Heaters
 - 72. Variable Frequency Drive Motor Bearing Protective Rings
 - 73. Variable Speed Drives
 - 74. Venturi Flow Meters
 - 75. Vertical In-Line Pumps
 - 76. Vibration Isolation Materials
 - 77. Water Treatment Services
 - 78. Weatherproof Assembly Components
 - 79. 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 work-manlike 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 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.
- E. All work associated with the existing roof shall be performed so as to maintain the existing roof warranty.

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 or 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. Paint the perimeter of all housekeeping pads safety yellow.

1.14. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. Unless otherwise noted on the drawings, where existing mechanical work is removed, pipes, valves, ductwork, etc., shall be 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 23 connects to existing equipment, piping, ductwork, 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 23, or under other Divisions, requires relocation of existing equipment, piping, ductwork, 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. Where existing insulation is disturbed, replace insulation where removed or damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.
- 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.

1.15. DEMOLITION

- A. Unless otherwise noted all existing equipment, piping, ductwork, etc., shall remain.
- B. Where existing equipment is indicated to be removed, all associated piping, conduit, power, controls, control panels, sensors, tubing, insulation, hangers, ductwork, supports and housekeeping pads, etc., patch, paint and repair walls/roof/floor to match existing and/or new finishes.
- C. Provide necessary piping, valves, traps, temporary feeds, drips, etc., as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time lengths of outages.
- D. The Contractor shall be responsible for visiting the site and determining the existing

conditions in which the work is to be performed.

- E. Where any abandoned pipes in existing floors, walls, ceilings, etc., conflict with new work, remove abandoned pipes as necessary to accommodate new work.
- F. The location of all existing equipment, piping, ductwork, etc., indicated is approximate only and shall be checked and verified. Install all new mechanical/plumbing/fire protection work to connect to or clear existing work as applicable.
- G. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the authorities having jurisdiction.
- H. Make provisions and include in bid all costs associated with confined entry/space requirements in all applicable OSHA regulations.
- I. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing piping systems to new piping systems with the appropriate shut-off valves.
- J. At completion of project all temporary piping, valves, controls, etc., shall be removed in their entirety.
- K. Existing piping, equipment, ductwork, materials, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- L. 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.
- M. 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 refrigerants. Contractor shall include in his bid all cost associated with the evacuation, removal and disposal of all existing equipment containing refrigerants in accordance with EPA and Health Department requirements.
- N. Where piping and/or ductwork is removed, remove all pipe or ductwork hangers which were supporting the removed piping or ductwork. Patch the remaining penetration voids with like materials and paint to match existing construction.
- O. 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.
- P. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.
- Q. The Owner shall have the first right of refusal for all fixtures, devices and equipment

removed by the Contractor.

- R. 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.
- S. 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.
- T. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- U. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- V. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.
- W. Where hydronic system piping and equipment is removed, Contractor shall be responsible for proper disposal of all contained fluids containing glycol (ethylene or propylene), hazardous waste and water treatment chemicals. Contractor shall include in his bid all associated costs with the removal, testing, and disposal of hydronic system fluid in accordance with EPA, Health Department, and the Local Authority Having Jurisdiction.

1.16. 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, 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.

1.17. 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.

1.18. 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".

1.19. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.20. REFRIGERANT SYSTEM CAPS

- A. For all exterior grade and roof 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.

1.21. 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, or 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, and unexcavated spaces.
- 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.

1.22. 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 mechanical devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.
- D. Department of Energy (DOE) compliance: Pump manufacturers shall comply with US Department of Energy (DOE) energy conservation standard for “clean water pumps” 1-200 horse power, less than 459 feet of head and greater than 25 gpm. These pumps shall be evaluated using the Pump Energy Index (PEI) of equal to or lesser than 1.0. the PEI number shall appear on the pump name plate and shall be available for the record at <http://er.pumps.org>.
- E. Where Energy Star certification exists for equipment utilized on this project, the equipment must be Energy Star certified. Provide Energy Star certification with submittals.

1.23. 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.

1.24. FUTURE ADDITIONS

- A. Where future additions are indicated, size and install all piping to account for future additions. Furnish and install shut-off valves, flow meters, 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.

1.25. COORDINATION WITH CAESAR RODNEY SCHOOL DISTRICT I.T. DEPARTMENT

- A. All equipment that interfaces with the internet shall be coordinated with the Caesar Rodney School District I.T. Department to verify that the same is suitable for use on the Caesar Rodney School District IT infrastructure. Coordinate with the Caesar Rodney School District I.T. Department regarding the allowable frequency bands to avoid interference with the Caesar Rodney School District I.T. infrastructure.

1.26. VFD BYPASSES

- A. When VFD's are specified with integral bypasses and the equipment manufacturer is not able to provide bypasses due to equipment space constraints, then the manufacturer must provide spare VFD's for each fan/pump.

1.27. A1 OR A2L REFRIGERANT REQUIREMENTS

- A. All refrigerants utilized on this project shall be lower flammability and lower toxicity refrigerants as defined by ASHRAE Standard 34-Designation and Safety Classification of Refrigerants. Per ASHRAE 34-2019, this project shall only utilize A1 or A2L refrigerants

in HVAC equipment such as R513A, R-32 and R-454B.

- B. Refrigerants classified as B-1, B2L, A2, B2, A3, and B3 shall not be utilized.
- C. All scroll compressor products shall be manufactured in compliance with UL-60335-2-40.
- D. All equipment including installations shall comply with ASHRAE 15-2022 requirements and International Mechanical Code requirements whichever is more stringent.
- E. The installing contractor shall submit a declaration to the authority having jurisdiction that the refrigerant systems have been installed and tested per ASHRAE 15-2022.

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.
- K. Where a motor disconnect is indicated downstream of a variable frequency drive (VFD) provide interlock wiring from the auxiliary contacts on the disconnect to the VFD to de-energize when the disconnect is turned "off".
- L. Where equipment under this Division is specified with integral disconnecting means, the same shall be a single disconnecting means for disconnecting all ungrounded main power supply conductors that is capable of being locked in the open ("off") position in accordance with the National Electrical Code and the local electrical inspector.

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
50HP and above	94.5 percent	88 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 two (2) 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.

2.6. ENCLOSURES

- A. Electrical enclosures including factory provided enclosures, field provided and installed enclosures, and automatic temperature control system enclosures shall be as follows:
 - 1. Dry Interior Locations: NEMA 1.
 - 2. Damp/Wet Locations, Including Exterior Locations: NEMA 3R.
 - 3. Corrosive Locations, Including Laboratories, Janitor's Closets, Chemical Storage

Rooms and Similar Space: NEMA 4X.

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 workman-like 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 chillers and 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.
- D. Where new concrete housekeeping pads are placed on existing concrete, saw cut the existing concrete to the perimeter dimension of the new pad to a depth of ½ inch. Break out the top ½ inch area of the existing concrete. Add stubs of #4 rebar angled into the existing concrete at a depth of approximately 50 percent of the existing slab thickness. The

top portion of the rebar stub shall extend into the new pad by approximately 50 percent of its thickness. Furnish one rebar stub per every two square feet of new pad. Chemically bond the new concrete to the existing concrete.

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 minimum of 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 20 inches x 30 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. Label inside of access door as to what it serves.
- 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, dishwasher 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, 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.

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.
- F. Provide moisture protection for ductwork in areas which are not under roof or where ductwork would be exposed to rainwater.

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 three (3) 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.
- H. Sleeves for penetrations in kitchen and food service areas shall finish .375 inches above floor or flush with wall surfaces and be neatly pointed up to fit snugly against floor or wall material.

- I. For renovation projects where new pipes or ducts penetrate existing floors, furnish ground penetrating radar to properly map out acceptable locations for pipe/duct penetrations. Review penetrations with Structural Engineer.

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 (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. Contractor shall repair and/or replace any/all damage to finishes and furniture resulting from their corrective work.
 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 three (3) 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 – Caesar Rodney School District – Magnolia Middle School – HVAC Renovations - 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. Electronic copies of the manual shall be saved on USB flash drives, and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of Volume 1 (if applicable) of hard copies of the manual.
- D. 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, chillers, hydraulic separators, variable frequency drives, air conditioning compressors.
 - 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 HVAC Inspector, Boiler Inspector, and Electrical Inspector 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.
 20. Letter stating final concentration of glycol in hydronic systems.
 21. Base mounted and split coupled vertical in-line pump shaft alignment test results.
- E. Electronic copies of the manual shall be saved on USB flash drives and shall be in searchable PDF format with interactive index tabs. Approved electronic copies shall be stored in flash drive zipper cases in front of volume 1 (if applicable) of hard copies of the manual.
- F. 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 twenty-four (24) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Heating, Chilled, & Glycol Water Supply & Return Piping, Including Chemical Treatment Piping	100 psig

- 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.

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. PHASING

- A. Refer to Specifications and contract drawings for any required phasing.
- B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities having jurisdiction.
- C. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.
- D. The Building shall remain watertight at all times.
- E. Refer to phasing plans for additional requirements.
- F. Provide necessary piping, valves, piping, conduit, controllers, ATC wiring, etc. as required. Drain and refill piping systems as often as necessary to accommodate phasing and to minimize time length of outages. Provide valves, etc., to maintain existing steam system in operation until all equipment is connected to the hot water system. Temporarily feed new systems with existing system where required or shown on contract drawings.
- G. At completion of the first phase the ATC System shall be sufficiently complete to turn over HVAC equipment. All wiring, testing, balancing, commissioning, programming, graphics, and ATC computer shall be completed and operational for all equipment in each phase prior to Owner taking ownership of the same.
- H. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the facility and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.
- I. Due to phased construction, some systems must be operated at part load conditions until later phases are completed. Contractor must carefully operate all variable speed pumps and variable speed fans so as not to operate below minimum speeds as required by pump/fan manufacturer.
- J. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.21. 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.

3.22. 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: _____

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DIVISION 23 SECTION 23 05 05
HVAC PIPING, FITTINGS & VALVES
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END OF SECTION 27

SECTION 23 05 05 - 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. 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.

C. 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. EXTRA MATERIALS

- A. Provide one (1) repacking kit for each size valve.

1.6. 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 & Chilled Water Supply & Return Piping, Chemical Treatment Piping, and Glycol Piping (Inside of Building):
 - a. Manufactures: Victaulic, Grinnell, or Sure-Joint.
 - b. 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.
 - c. 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.
- d. Flanges: Wrought steel Class 150 welding neck. ASTM Standard B16.5.
 - e. 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 ANSI 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.
 - f. 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.
 - g. 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.
 - h. 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.
 - i. 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.
 - j. 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.

- k. Butterfly Valves: Victaulic Vic300 MasterSeal/ AGS-Vic300, DeZurik, Apollo 215L series, high performance, Milwaukee High Performance Valve, 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.
- l. 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. Where required for flow rates below 0.6 GPM, provide "reduced flow" combination shut-off balance valves sized so that the flow rate is within the manufacturer's recommended flow range.
- m. 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.
- n. 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, copper press fittings may be utilized as manufactured by Viega Pro Press/ Mega Press, Apollo Press/Apollo Power Press, or Mueller Streamline Co. Viega, ProPress, and Mueller Streamline Co. 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 leak detection feature.

2. Cooling Coil A/C Condensate Drain 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. Also install cleanout at all equipment traps for cleaning and service.
- b. Exterior condensate pipe penetrations must exit exterior wall above flashing. Extend discharge away from exterior walls as detailed.

3. 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. Extended Valve Stems:
 - i. 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 insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve handles outside of insulation.

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.

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, Victaulic, or Shurjoint for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal Victaulic, Shurjoint, Carpenter Patterson, 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

Victaulic or Shurjoint. 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
6	16	14	3/4

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
8	18	16	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, supports, brackets, hardware and anchors.
- T. For pipe hangers installed in corrosive environments such as chemical storage rooms, janitor closets...etc. the same shall (including hardware) shall be finished with on Electro-Galvanized Finish such as Galv-Krom® or approved equal.

2.3. HYDRONIC BELLOW EXPANSION JOINTS

- A. Metal expansion joints shall consist of a single hydraulically formed metal bellows with flange end fittings. Flanges shall be carbon steel and ANSI B16.5 150# type. The bellows shall be 316 stainless steel.
- B. Joints shall be designed to meet the design pressures and temperature for the system, and shall be capable of accommodating piping system and equipment movements as needed.
- C. Tie rods shall be included to prevent overextension of the expansion joints from pressure thrust loads. The number and size of the control rods shall be sufficient for the maximum system test pressure.
- D. Expansion joints shall be Flexicraft Industries Model NLC, MetraFlex, Thunder Technologies, or approved equal.

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, Grinnell, or approved equal suitable for service intended. Check valves in circulator discharges shall be "non-slam" 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 240°F. 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, Grinnell, 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, Grinnell, 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. Chilled water systems: 0 degrees F to 100 degrees Fahrenheit, 1 degrees Fahrenheit Division
 - 2. 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 METER FITTINGS

- A. Griswold or Bell & Gossett Venturi disturbed flow measurement quickset flow meter fittings shall be utilized for hydronic flow measurement. 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.

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, split coupled vertical inline pumps, and vertical in-line pumps, connections to chillers, all vibrating equipment, and elsewhere as shown. Pump flexible connections shall be utilized at pumps. 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 boilers, chillers, 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 ¾-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 fittings 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.
- U. Due to phased construction and the fact that we are connecting to the existing piping systems in various locations, all new and existing piping shall be cleaned, flushed, and purged of air. All new and existing strainers shall be pulled and cleaned. Document strainer cleaning with digital photographs and include in the Operation and Maintenance Manuals.

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. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. 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.)

- B. 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.
- C. Brazed 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 brazing material per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
 - 5. Brazed joints shall be made by using a direct flame from a torch.
 - 6. On pipe sizes larger than 1/4-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the brazing material starts to melt to insure an even distribution of the brazing material.
 - 7. The excess brazing material shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
 - 8. Brazed joints shall be suitable for working pressure of 550 psig and for working temperature of not less than 250 degrees F. The type of brazing material 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.
- D. Where copper piping joins steel piping, approved bronze adapters shall be used.
- E. Prohibited Connections: No direct weld 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.

3.6. 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.
- 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.

3.7. 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.

3.8. EXPANSION FITTINGS 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.

3.9. 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)
$\frac{1}{2}$ to $1 \frac{1}{4}$	8	$\frac{1}{2}$
$1\frac{1}{2}$ to 2	8	$\frac{3}{4}$
$2 \frac{1}{2}$ to 6	12	$1 \frac{1}{4}$
8 to 10	24	$2 \frac{1}{2}$
Over 10	32	$3 \frac{1}{2}$

3.10. 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 three (3) 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.

3.11. CLEANING PIPING AND EQUIPMENT

- A. All chilled water, and heating water 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. New piping systems shall be cleaned, flushed, and purged.

- C. All chilled water and heating water 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. Where indicated, hydronic systems shall be filled with 30 percent by volume antifreeze.
- D. 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.
- E. All new and existing strainers shall be inspected and cleaned prior to testing and balancing. In addition, prior to substantial completion, contractor must inspect and clean all new and existing strainers.
- F. Where new equipment is connected to existing piping systems, install temporary bypasses as required for flushing new equipment piping.

3.12. 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.

3.13. CLEANING/FLUSHING/PURGING PIPING AND EQUIPMENT

- A. The Contractor shall submit a detailed written flushing plan including shop drawings depicting locations of temporary bypasses, strainers, vents, drains, isolation valves and temporary spool pieces for review and approval by the Engineer of Record.
- B. All chilled water and heating water 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 five (5) days during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water and antifreeze and purged of all air.
- 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.

E. Flushing & Treatment:

1. The chilled water and heating water systems shall be thoroughly flushed and treated.
2. Flushing and Treatment shall be witnessed by representatives of the Mechanical Contractor, Chemical Treatment Contractor, Engineer of Record, and Owner.
3. The phasing layout and complexity of the piping system may require the system to be separately flushed in sections.

F. Chemical Water Treatment Contractor:

1. The Contractor shall submit to the Engineer of Record the Proposed Chemical Treatment Contractor Company information and Qualifications along with the proposed chemical cleaning, dispersant, & inhibitor brands and concentrations of the chemicals for review and approval.

G. Pumps:

1. Temporary Pump System:

- a. The incorporation and use of temporary pump systems is recommended for the flushing & cleaning process. The Contractor shall size the temporary pump system to ensure a fluid velocity of 6 FPS through the largest pipe diameter in the system.
- b. The Contractor shall submit documentation to the Engineer of Record for approval of the proposed temporary pump system. This shall include pump curves, flow meters to prove the required velocity, pressure gauges, connection details and temporary power requirements along with a written description and photos of the proposed temporary pump system.

2. Permanent Facility Pump Systems:

- a. In the event temporary pumps cannot be utilized for the flushing and cleaning process, the existing permanent facility pump systems may be used only with prior approval of the Engineer of Record. The Contractor shall submit documentation to the Engineer of Record for approval of the proposed use of the Permanent Facility pump system. This shall include verification that the permanent facility pump system is capable of achieving the required fluid velocity of 6 FPS through the largest pipe diameter in the system, pump curves, flow meters to prove the required velocity, pressure gauges, connection details and power requirements along with a written description and photos of the proposed Permanent Facility pump system.

- b. In exchange for the use of the permanent facility pump system, The Contractor shall engage the Pump Manufacturer at the end of the cleaning/flushing process to disassemble the pump bodies and fully inspect the condition of the impellers, seals, bearings, wear rings, and motors for any damage caused by the flushing process. The Pump Manufacturer shall provide a written report with documenting photos of the condition of the pump system to the Engineer of Record. The permanent facility pumps must be in new condition and unconditionally warranted for a period of 2 years from the date of Project Substantial Completion. In the event a pump or pumps fail and is proven to be a result of the cleaning/flushing process during the 2 year warranty period the Contractor shall provide an additional 2 year extended warranty from the date of repair/replacement on the failed pump system.

H. Bypasses, Vents, Drains, Strainers, Isolation Valves, Temporary Spool Pieces & Hoses:

The Contractor shall prepare the piping system to ensure equipment and fragile devices are protected from damage caused by the flushing process.

1. The Contractor shall isolate & bypass all major equipment, heat pumps, ERV units, make-up air units, coils, ancillary equipment, control valves, check valves, insertion type & inline flow meters and any other fragile device that may be damaged as a result of the cleaning/flushing process. The Contractor shall incorporate the use of Line Size temporary flanged / union spool pieces in locations where fragile devices were removed.
2. The Contractor shall install high point air vents and low point drains where required. The layout of the piping system may require additional secondary high point vents and low point drains to ensure the system can be fully vented and drained during the cleaning/flushing process. The Contractor shall depict on the Flushing procedure shop drawings all required and secondary vents & drains. Secondary vents and drains shall be at No additional costs to the Owner.
3. The Contractor shall provide and install strainers where required.

I. Flushing Operation:

1. Pre Flush - Bypass loops should be installed at all equipment components. Strainers can be removed when a self-contained purge unit is used in conjunction with on board filtration. Flush ports should be identified along with the type of high pressure hose or piping that will be used to connect to the system. The water source should be identified and must be adequate to fill and make up water in a timely manner to the system during the flush process.
2. Clear Water Flush – Fill the piping system with clean potable water. The first flush is a clear- water flush intended to circulate water through the system and force loose debris to low point drains and the flush cart filtration system. This flush should be at minimum velocity throughout the system of 5 to 7 ft/sec. Filtration size shall be 25 micron.
3. Cleaning & Passivation - The second flush cycle is a combined flushing cycle

where cleaning and passivation chemicals are introduced into the system to clean the oils and treat the inside wall of the piping system. This process will be monitored by the chemical treatment company to meet the chemical specifications of the water. The cleaning velocity should be between 3 to 5 ft/sec and the circulation time will be based on the chemical testing but will typically be up to 48 hours.

4. A circulation pump shall be sized to meet a fluid velocity of 6 FPS in the largest pipe main. Add by-pass piping for continuous circulation at each end where required.
5. The system shall be filled from the lowest available point; all vents and high point connections shall be open during this operation to allow the air in the system to vent off. Fill system with fresh water and circulate for 12-24 hours and flush to remove large sediment first.
6. Drain system from all lowest possible points and refill with fresh water.
7. Add a System Cleaner/Dispersant: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products, similar to Bond - 8050 Closed System Cleaner, at a dosage of 15 gallons per 1000 gallons of system volume, and circulate for 24 hours.
8. All new installed equipment (such as expansion tanks, etc.) which are not to be subjected to chemical cleaning and flushing, shall be disconnected from the piping. Add by-pass loops at each branch pipe to ensure continuous circulation of flushing fluids. Circulating pump must run continuously during the entire cleaning and flushing procedure to assure proper cleaning.
9. Drain system from all of the lowest points until the pH is equal to fresh potable water make-up (< 8.0).
10. Circulate the system water again after flushing for 12 hours, then drain system again if water is still turbid.
11. If system water is clean at test valves on lower section of system proceed to step 13. If the system is still turbid fill circulate for another 12 hours and flush until it is clear.
12. Refill system with fresh water and add corrosion inhibitor, similar to Bond-5010 Molybdenum, to system water to achieve the desired residual (50-150ppm).
13. The system must be tested after 2-3 weeks of operation to ensure the chemical residual is adequate and maintained.
14. Submit Piping System Flushing report of cleaning and flushing. Report is to include largest main, circulation pump sizing (flow and head), system volume (in gal), amount of cleaning agent added (in gal), flush start date and time and end date and time, amount of chemical added, water quality parameters and chemical residual after 2 week operation period.

15. Treatment – After cleaning and before adding chemical initial charge, system must be flushed to meet these minimum requirements:
 - a. Conductivity no higher than 20 micromhos above domestic water level
 - b. No foam
 - c. Copper level less than 0.5 ppm
 - d. Iron level less than 1.0 ppm
 - e. pH 9.4 or less
 - f. Less than 1 ppm phosphates (ortho-phosphate PO₄)
16. Final Clear Water Flush – The system will be continuously flushed while discharging chemicals into the sanitary system as approved locally. As the existing treated water is being discharged a fresh water make-up source will be utilized to ensure air is not introduced into the system. Continue to drain the system while adding domestic water to dilute the treated water. The chemical treatment company will monitor the outgoing water composition and compare the composition with the incoming water. Flush with fresh water until the conductivity is reduced to that of the make-up water and iron level is 1.0 ppm or less the final system water should be approved by the chemical treatment company. Filtration should be 5 micron.
17. Final Chemical Fill – Once the chemical treatment company has determined the system has been brought back to the correct composition, the chemical treatment company will inject the final chemicals into the system. Once the system is filled with the final chemicals it is important that the water is not to be left stagnant.
18. Verify satisfactory completion of clean pipe and a final flushing and chemical treatment report should be signed by field personnel and submitted.
19. Treat and test chilled water and heating water systems monthly for the entire 24 month warranty period.

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DIVISION 23 SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC, PLUMBING & FIRE PROTECTION EQUIPMENT
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SECTION 23 05 48 - 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. MANUFACTURERS

- A. Isolators shall be the equivalent of the following types by Mason Industries, Inc., Korfund, Inc., Kinetic Noise Control, Inc., Vibro Acoustics 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.
- C. Restrained Spring Isolator: Equipment with operating weight different from the installed weight such as chillers, boilers, etc. and equipment exposed to the wind such as air cooled chillers, fans, and roof mounted condensing units, shall be mounted on spring mountings as described above, but a housing shall be used that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection and mounts shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same. A minimum clearance of ½" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations. Mounting shall be type SLR.

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 30° 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 30° 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 30° 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 30° 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 30° 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 220°F. 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"

- 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 chillers, and boilers, and where indicated. 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, and boilers. 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 360 degrees 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. 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. Chilled Water and Hot Water 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.

3.3. 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.

3.4. 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:
 - 1. All base mounted pumps shall be mounted on concrete inertia bases 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 in-line pumps.
- C. Ducted Fan Coil Units, Energy Recovery Ventilators, Single Zone VAV Units:
 - 1. All ducted fan coil units, energy recovery ventilators, and single zone VAV units shall be supported on stable steel springs in series with ribbed neoprene pads selected for not less than 2.0" 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 1.0" static deflection (Mason Industries Type SLF or equivalent).
2. 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 2.0" static deflection under full load (Mason Industries Type 30N or equivalent).

E. Chillers: Chillers shall be mounted on restrained spring isolator with vertical limit stops for not less than 1 inch static deflection under full operating load. Isolators shall be Mason Industries Type SLR or as approved equal. All exterior isolators for chillers shall be hot dipped galvanized including all hardware. Provide neoprene coated springs.

F. All unit heaters and ductless fan coil units 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).

3.5. MANUFACTURER'S FIELD SERVICES

A. Inspect isolated equipment after installation and submit report. Include static deflections.

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DIVISION 23 SECTION 23 05 93
TESTING, ADJUSTING & BALANCING FOR HVAC & PLUMBING
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SECTION 23 05 93 - 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 systems as specified in Division 23 Section, Heating, Ventilating, and Air Conditioning 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 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. Where balance valves and/or flow meter fittings are not indicated utilize ultrasonic flow meter to record fluid flow rates in gallons per minute.
 - 1. Perform all work required to prepare the building HVAC and Plumbing systems for testing, adjusting, and balancing indicated by the Contract Documents as follows:
 - a. Verify the air systems are ready for balancing.
 - b. Verify the hydronic systems are ready for balancing.
 - c. Verify the control systems are ready for balancing.
 - d. Notify appropriate parties the system is ready for balancing.
 - 2. Scope of work.
 - a. Testing, adjusting, and balancing (TAB) of the HVAC systems, Plumbing Systems, and related ancillary equipment will be performed by an independent, third party, AABC Certified Agency, selected and employed directly by the Contractor. The preparation and corrections necessary for the testing and balancing of these systems, as described herein, are the responsibility of the Contractor.
 - b. As part of the project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, or other components required for correct balance as advised by the TAB Agency, at no additional cost to the Owner.
 - c. The Contractor shall provide and coordinate the services of qualified, responsible subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.
 - d. In order that all systems may be properly tested, adjusted and balanced as

required herein by these Specifications, the Contractor shall operate the systems at their expense for the length of time necessary to properly verify their completion and readiness for TAB, and the entire duration required for the TAB process.

- e. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner-provided services during the construction period and prior to Substantial Completion, as defined in the AIA General Conditions and Supplementing Condition of this Construction Document.
- f. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices to be adjusted to obtain optimum operating conditions. It is the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access, as requested by the TAB Agency. Any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with a minimum of delays.
- g. The scope of work, as defined herein, is to advise the Contractor of the coordination, adjustment, and system modifications that will be required under the project work to complete Owner requirements for final TAB. The Contractor's original bid shall allow for the costs of all work which may be required in the TAB phases, and which may be necessary for the completion of the TAB work as defined by the TAB Agency.

3. Submittals. The TAB Agency shall submit an agenda that will include:

- a. Field observation reports.
- b. An overview of system TAB procedures.
- c. System testing which will include where ducts will be traversed, which instrumentation will be used, how correction factors for grille and diffuser will be obtained, how measurements will be verified at maximum and minimum, and how control components will be verified.
- d. Report forms with each system's components identified and numbered.

E. The items requiring testing, adjusting, and balancing include, but are not limited to, the following:

Air Systems:

- 1. Air Flow Monitoring Stations
- 2. Air Handling Units
- 3. Coils (Air Temperatures, Fluid Temperatures, Fluid Pressure Drops, & Static Pressure Drops)
- 4. Chiller Condenser Fans
- 5. Diffusers, Registers and Grilles

6. Duct Smoke Detectors
7. Energy Recovery Ventilators
8. Electric Radiant Heat Panels
9. Exhaust Fans
10. Fans
11. Fan Coil Units
12. Fire Dampers
13. Heat Recovery Systems
14. Heat Pipes
15. Intake Hoods
16. Outside Air Intakes
17. Relief Hoods
18. Single Zone VAV Units
19. Static Pressure Sensors
20. Supply Fan AHU
21. Unit Heaters
22. Ventilation Fans
23. Zone Branch and Main Ducts

Hydronic Systems:

1. Automatic Glycol Feeders
2. Boilers
3. Chemical Feed Tanks
4. Chillers
5. Coils
6. Condensate Pumps
7. Condensate overflow safety switches

8. Differential Pressure Bypass Valves
9. Energy Recovery Ventilators
10. Fan Coil Units
11. Flow Measuring Stations
12. Flow Meter Fittings
13. Flow Switches
14. Fluid Filter Housings
15. Glycol Feed Pumps
16. In-line Pumps
17. Minimum Flow Bypass Valves.
18. Pumps
19. Single Zone VAV Units
20. System Mains and Branches
21. Unit Heaters

1.2. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

1.3. GENERAL COMMISSIONING REQUIREMENTS

- A. Refer to Division 01 Section, "General Commissioning Requirements" for description of work under this Division affected by General Commissioning.

1.4. PRELIMINARY 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 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.

1.5. 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.
- D. All personnel used on the project will be employees of an AABC Certified Agency. All work will be performed under the direct supervision of the AABC Certified Test and Balance Engineer (TBE). All work will be performed with AABC Certified Test and Balance Technicians (TBT) Resumes including education, experience, and certification of each person on the project shall be submitted.
- E. Warranty. The AABC Agency shall submit a National Project Performance Guaranty.

1.6. PERSONNEL

- A. All personnel used on the project will be employees of an AABC Certified Agency. All work will be performed under the direct supervision of the AABC Certified Test and Balance Engineer (TBE). All work will be performed with AABC Certified Test and Balance Technicians (TBT). Resumes including education, experience, and certification of each person on the project shall be submitted as informational submittals.

1.7. WARRANTY

- A. The AABC Agency shall submit a National Project Performance Guaranty.

1.8. PRE-BALANCING CONFERENCE

- A. Convene a conference one week prior to commencing work of this Section with all appropriate individuals.

1.9. 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

1.10. 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.

1.11. 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.

1.12. RESPONSIBILITIES OF THE TAB AGENCY

- A. Liaison and Early Inspection. The following reviews, observations, and tests shall be performed by the TAB Agency:
1. Review the mechanical drawings and specifications for balanceability and provide commentary. Verify proper types and locations of all Test and Balance devices.
 2. During construction, review all approved HVAC submittals such as control diagrams, air handling devices, hydronic devices, and other components that pertain to TAB work and balanceability. Assist the commissioning agent with all Functional Performance Testing.
 3. Perform construction observations and submit a written report:
 - a. On the ductwork prior to insulation and/or ceiling cover-up.
 - b. On the piping prior to insulation and/or ceiling cover-up.
 4. Witness duct pressure test as defined in the specifications, and submit a written report.
 5. Perform a pre-balance site review, and submit a written report.
 6. During the balancing process, abnormalities and malfunctions of equipment or components may be discovered by the TAB personnel. The Construction Inspector, Architect, Engineer, and Owner shall be advised in writing so that the condition(s) can be corrected by the Contractor. The written document need not be formal, but shall be understandable and legible. The TAB Agency shall not instruct or direct the Contractor in any of the work, but will make reports to the appropriate parties.
- B. Final Air Balance. When systems are complete and ready for operation, the TAB Agency will perform a final air balance for all air systems and record the results. The volume of air for the supply, return, exhaust, and outside air equipment and terminals will be tested and balanced within the tolerances of the AABC Standard, or as specified, whichever is more stringent. Air handling unit and fan volumes shall be adjusted by changing fan speed. Air distribution device volumes shall be adjusted using the duct dampers and not the grille face. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Agency will include, but is not limited to, the following:
1. Filters: Check air filters and filter media. Balance systems with essentially clean filters and filter media.
 2. Fan Speed: Measure and record RPM for each fan. Provide Controls Contractor with drive parameters for variable speed drives.
 3. Voltage and Amperage Readings: Measure and record the final operating voltage and amperage for each motor.

4. Static Pressure Profile: Static pressure profiles shall be measured and recorded across each supply fan, cooling coil, heating coil, heat of rejection equipment fans, return air fan, air handling unit filter, exhaust fan, and at the furthest air device or terminal unit from the air handler supplying that device.
 5. Equipment Air Flow: Adjust and record supply, return, outside and exhaust air CFM and temperatures, as applicable, at each fan and coil.
 6. Coil and/or Heat Exchanger Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb (cooling only) temperatures at each cooling coil, heating coil, and HVAC terminal unit. At the time of reading, record water flow and entering and leaving water temperatures and pressure drops. In variable flow systems, adjust the air and water flow to design for all the above readings.
 7. Zone Air Flow: Adjust each HVAC terminal unit and each air-handling unit for design CFM.
 8. Outlet Air Flow: Adjust each supply diffuser, register and grille, and each exhaust inlet to within the tolerance per the AABC Standard.
 9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all main supply, return, outside air, and exhaust ducts shall have air velocity and volume measured and recorded by the Pitot tube traverse method shown in the AABC Standard. Locations of these traverse test stations shall be described on the sheet containing the data. All Pitot tube traverses shall be clearly identified on the outside of the duct insulation with the traverse identified and duct size. Submit half scale drawings showing the locations of all duct traverses.
- C. Final Water Balance. When systems are complete and ready for operation, the TAB Agency will perform a final water balance for each hydronic HVAC system. The general scope of balancing by the TAB Agency will include, but not be limited to, the following:
1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow per the AABC Standard. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps, and obtain GPM flow from the pump curve. Permanently mark the balanced position for each valve. If discharge valves on the pumps are used for balancing, record the head being restricted by the valves. Test and record autoflow valve differential pressures and adjust pump speed to optimize and minimize outflow differential pressure.
 2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter, heat rejection equipment and heat exchanger at design flow. Adjust as necessary to secure design operating conditions. Provide final readings at all thermometer well locations.
 3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow and through flow measuring stations, where provided and installed, at each hydronic unit. The flow of water through all water coils shall be adjusted by balancing valves until the rated pressure drop across each coil is

obtained and total water flow is verified by flow measuring station. For coils equipped with three-way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until the pressure drop between supply and return connections is the same as with the flow through the coil.

4. Voltage and Amperage Readings: Read and record the final operating voltage and amperage for each pump motor.
5. Pump Speed: Measure and record RPM for each pump. Provide Controls Contractor with drive parameters for variable speed pumps.

D. Testing of Temperature Control Systems as applicable to the project.

1. Air Handling Units

- a. Start each air handling unit; verify and document:
 - Dampers modulate properly and in the correct sequence.
 - Fan(s) VFD ramps to design speed or proper controlled speed.
 - All coil valves operate in response to the controlled temperature.
 - All interlocked fans and/or devices energize.
 - All alarms and safeties are operational and will alarm or shut down the unit.
 - All operating scenarios are tested; e.g.: economizer cycle, minimum/maximum airflows, outside airflows at unit minimum/maximum volume, and special sequences.
 - All end switches and positioners are properly set.
 - All pressure controllers respond to increases or decreases in system pressure.
 - All temperature and pressure sensors are calibrated.
 - Airflow monitors report the correct airflow and control devices respond correctly to a change in airflow; e.g.: outside air control.
 - Reset control sequences operate in response to changes in system temperatures, flows, or pressures.
 - Correct operation of fan sequences when multiple fans are installed.
 - Test all static pressure sensors and controls and calibrate the same.
- b. Shut down each air handling unit; verify and document:
 - Dampers respond properly (open, close, or modulate), and in the correct sequence.
 - All fan systems ramp down and stop.
 - Correct operation of fan sequences when multiple fans are installed.
 - Emergency mode operation; e.g.: freeze protection.
 - Interlocked devices turn off.
 - System starts for setback temperature control.
 - System starts on a temporary occupancy override.
 - All coil valves go to their specified position.
 - All alarms and safeties remain operational.

2. Fan Systems

- a. Start each fan or fan system; verify and document:
 - Interlocks and lockouts operate in accordance with the sequence.
 - Fan(s) VFD ramps to design speed or proper controlled speed.
 - All alarms and safeties are operational and will alarm or shut down the fan.
 - Dampers modulate properly and in the correct sequence.
 - All interlocked fans and/or devices energize.
 - All end switches and positioners are properly set.
 - All pressure controllers respond to increases or decreases in system pressure.
 - All temperature and pressure sensors are calibrated.
 - Airflow monitors report the correct airflow and that control devices respond correctly to a change in airflow; e.g.: outside air control.
 - Correct operation of fan sequences when multiple fans are installed.
- b. Shut down each fan or fan system; verify and document:
 - Dampers respond properly (open, close, or modulate) and in the correct sequence.
 - All fan systems ramp down and stop.
 - Correct operation of fan sequences when multiple fans are installed.
 - Emergency mode operation; e.g.: purge air.
 - Interlocked devices turn off.
 - All alarms and safeties remain operational.

3. Hydronic Systems

- a. Start hydronic systems; verify and document:
 - Valves modulate properly and in the correct sequence.
 - Pump(s) VFD ramps to design speed or proper controlled speed.
 - All isolation valves go to their “system on” position.
 - All coil valves operate in response to the controlled temperature.
 - All reset and changeover valves operate in response to the control system.
 - All interlocked devices energize.
 - All alarms and safeties are operational and will alarm or shut down the system.
 - All operating scenarios are tested; e.g.: minimum/maximum water flows, minimum/maximum pressure, and special sequences.
 - All end switches and positioners are properly set.
 - All pressure controllers respond to increases or decreases in system pressure.
 - All temperature and pressure sensors are calibrated.
 - Flow meters report the correct water flow and that control devices respond correctly to a change in water flow.
 - Reset control sequences operate in response to changes in system temperatures, flows or pressures.
 - Differential pressure across all autoflow valves, flow meters, PIC valves, coils, heat exchangers and equipment.
 - Correct operation of pump, HVAC equipment, and/or heat exchangers

sequences when multiples are installed.

- The controls have time delay strategy to avoid excessive cycling of pumps and coils.

b. Shut down hydronic systems; verify and document:

- Valves modulate properly and in the correct sequence.
- Pump(s) VFD ramps down to off position.
- All isolation valves go to their “system off” position.
- All coil valves go to their normal off position.
- All interlocked devices de-energize.
- All changeover valves go to the normal position.
- All alarms and safeties remain operational.
- Correct shutdown of pump, HVAC equipment, and/or heat exchangers.

4. Component Calibration

All temperature, airflow, fluid flow, pressure, and flow measuring components shall be measured and compared to the control system readout; verify and document:

- The air temperature sensors for each coil, heat exchanger. If the temperature is not reading within tolerance, the sensor will be reported to the control contractor for calibration.
- The room temperature, relative humidity, and CO₂ sensors. If the sensors are not reading within tolerance, the sensors shall be reported to the control contractor for calibration.
- The water temperature sensors for each coil, heat exchanger. If the temperature is not reading within tolerance, the sensors shall be reported to the control contractor for calibration.
- All air and water pressure sensor readouts. If the pressure is not reading within tolerance, the sensor shall be reported to the control contractor for calibration.
- All flow measuring device readouts. If the flow readout is not recording within tolerance, the sensor shall be reported to the control contractor for calibration.

5. Point Verification

- Point verification for the digital control system documents that every point is operational and the setpoint, flow, temperature, or pressure is reporting correctly to the graphic interface. Verify and document all points.

6. Dynamic Testing

- Dynamic testing involves making a change of value at the sensor in order to observe the system’s reaction and how it regains the original setpoint. Verify and document the system’s response.

1.13. REPORTS

- A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. The report summary is a project narrative describing the outcome of the testing and balancing and shall include a list of items that document all system variations deviating from design tolerances. Information can also be included that suggests possible resolutions.
- B. All measurements and recorded readings that appear in the reports shall be certified by the Agency's Test and Balance Engineer.
- C. Submit reports on forms approved by the Engineer. Hard and/or electronic copies of the final report shall be submitted in accordance with the Contract Requirements. The report shall indicate a summary of actual operating data and any abnormal operating conditions. The report shall contain all required information as described within this specification, including the information formatted and shown in the AABC Standard.
- D. For phased projects, submit a final, complete, and comprehensive TAB report with index for all phases.
- E. When the Engineer reviews TAB reports and provides comments, address each comment in writing for all re-submitted TAB reports.

1.14. TAB FINAL ACCEPTANCE INSPECTION

- A. At the time of TAB final acceptance inspection, the TAB agency shall recheck, in the presence of the Owner's representative, specific and random selections of data recorded in the certified test and balance report.
- B. Points and areas for recheck shall be selected by the Owner's representative.
- C. Measurements shall be verified at the same test conditions as the submitted and approved test and balance agenda.
- D. Selections for verification shall not exceed 10% of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.
- E. If 10% of the random verification tests demonstrate a measured flow deviation of 10%, or more from that recorded in the certified test and balance report, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance submitted, and a new inspection test made. There shall be no additional cost to the Owner for this work.
- F. Final acceptance shall occur after successful completion of the TAB verification process.

1.15. RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

- A. The mechanical contractor shall sufficiently complete the installation and start all HVAC and plumbing 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. The Contractor shall:
 - 1. Have the building, air conditioning systems, heating systems, and plumbing systems in complete operational readiness for TAB work to begin.
 - 2. The Contractor shall allow sufficient time for the TAB Agency to perform their contracted work within the construction schedule. The Contractor shall complete work by systems or floors, whichever is the most efficient for testing systems. After award of the contract and the completion of the construction schedule by the Contractor, a TAB coordination meeting shall be held with the TAB Agency, the Contractor and primary subcontractors, including but not limited to mechanical, electrical, and building automation subcontractors to develop a testing schedule for the project. The Contractor shall submit copies of the proposed schedule to the TAB Agency two weeks prior to this meeting.
 - 3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.
 - 4. Be responsible for any added costs to the Owner resulting from the Contractor's failure to have the building air conditioning systems and plumbing systems ready for TAB when scheduled, or from the Contractor's failure to correct deficiencies promptly.
- D. Facility Operational Readiness
 - 1. Complete operational readiness of the building requires that the building envelope be complete. This includes the installation of doors, windows, and ceilings to obtain simulated or projected operating conditions.
- E. 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 and fire dampers 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, operational, and sealed tightly.
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. Coils shall be clean with fins straightened, bearings shall be properly greased, belts shall be aligned and tightened, and the system shall be completely operational. The Contractor shall verify that all systems are operating within the design pressure limits of the piping and ductwork.
10. All supply, return, exhaust, and relief fans shall be operating and verified for: freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating, as the as per the starter manufacturer. Record motor amperage and voltage on each phase at start-up, verifying they do not exceed nameplate ratings.
11. All terminal units shall be installed and functional. Controls commissioning shall be complete.

F. 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 on each phase and voltage, to ensure that motors do not exceed nameplate rating.
5. Provide thermal overload protection of proper size per the starter manufacturer 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.

7. All piping shall be terminated and pressure tested for leakage as required by the specification. All valves shall be set to their full open position, bypass stop valves shall be closed, and mixing valves shall be set to full-flow through the the system's components. After the system is flushed and checked for proper operation, all strainers shall be removed and cleaned. The Contractor shall repeat the operation until circulating water is clean. The start-up strainers shall then be removed and hung adjacent to the pumps.
8. Chemicals shall be added to closed systems to treat piping and inhibit corrosion. The system static pressure shall be adequate to completely fill the system without operating the pumps.
9. The operating parameters of the heat exchangers, coils, pumps, and control devices shall be capable of obtaining design requirements.
10. Proper balancing devices shall be installed in the designated locations. These devices include but are not limited to flow meters, pressure taps, thermometer wells, and balancing valves.

G. Notification of System Readiness

1. After completion of the work, the Contractor shall notify the Owner and TAB Agency, in writing, certifying that the work has been accomplished and that the building, air conditioning, and plumbing systems are ready for testing, adjusting, and balancing. The Contractor shall include a copy of the tabulated data of the start-up reports.
2. The Contractor shall notify the TAB Agency of the readiness for balancing and forward copies of the Contractor's certification and the tabulated data.
3. Should the TAB Agency be notified as described above and the inspection reveal the TAB services notification to have been premature, all costs of the inspection by the TAB Agency shall be reimbursed by the Contractor.

1.16. CONTRACTOR SUPPLIED ITEMS

- A. As a requirement of the TAB contract, the Contractor's Project Manager shall compile and provide the TAB Agency the following:
1. One set of mechanical specifications.
 2. All pertinent change orders.
 3. All Request(s) for Information (RFI).
 4. One complete set of MEP Drawings.
 5. One copy of approved submittal data on equipment installed and controls submittal with sequences of operation.
 6. All HVAC Control Communications software with the appropriate licenses and

hardware interfaces.

7. All Addendums and RFI's (Requests for Information).

1.17. 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, high and low temperature thermostats, safeties, 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.
 5. The Control Contractor shall schedule a meeting with the Mechanical Contractor, TAB Agency, and Owner's representative for a pre-submittal review to establish that their interpretation of the control sequence is correct.
 6. The Control Contractor shall verify that all controlling instruments are calibrated and set for design operating conditions, with the exception of components that require input from the TAB Agency. A default shall be set for such components. The Control Contractor shall cooperate with the TAB Agency and provide all software and interfaces necessary to communicate with the system.
 7. The Automatic Temperature Control Contractor shall thoroughly check all controls, sensors, operators, and sequences before notifying the TAB Agency that the Energy Management System is operational. The Energy Management System Contractor shall provide technical support in the form of technicians and necessary computers to the TAB Agency for a complete check of those systems.
 8. The Fire Alarm (FA) Contractor shall thoroughly check all detection devices, sequences, interlocks, and other components before notifying the TAB Agency that the system is operational, including the Fireman's Override Panel. The FA Contractor shall provide all documentation that identifies all fire and smoke detection devices, all smoke zones, and all alarm and event chart devices. The FA

Contractor shall certify to the Contractor that the systems are totally operational prior to the start of TAB.

- 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.

1.18. 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 and plumbing 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.
- C. Mechanical Contractor shall notify the General Contractor of the start date of this portion of the work.

1.19. 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.
- C. TAB Agency shall notify General Contractor of all deficiencies found during initial survey.

1.20. 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. For exterior ductwork, the duct traverse locations must be identified with waterproof labels.

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 ½ 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/plumbing system and equipment controls.
- E. 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.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. 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.
- I. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens and indicated perforations.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine operating safety interlocks and controls on HVAC equipment.

- N. 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 kitchen hood exhaust taps, 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. 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.
 - 11. Identification - Identify the location and area of each grille, diffuser, register, and fan coil unit. This information shall be recorded on air outlet data sheets.

12. Description - Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.
13. Minimizing Drafts - Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
14. 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.
15. 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.
16. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
17. For all equipment specified with condensate overflow safety switches/floats test operation of such device and record results. Verify interlock with ATC system.
18. 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).
19. 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 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 chillers, 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. Chillers:

1. Verify that chillers have been started by others and are in operation. Test and adjust chiller water flows to achieve maximum or design GPM.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure compressor motor is not in or above the service factor.
3. Test and record temperature profiles of chillers.
4. Description of liquid sufficient to obtain physical properties.
5. Power input to controls and auxiliary components in KW.
6. Dry bulb temperature of air entering condenser (degrees F).
7. Condenser fans motor power consumption in KW.
8. Condenser fans rotating speed in rpm.
9. Test operation of flow switches.

F. 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 boilers.
5. Test flame failure alarms and low water cut-off alarms.
6. Test condensate block alarm.
7. Test Flow Switches.

G. 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. 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 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.

3.6. 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.

3.7. 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 fluid and airside differential pressure sensors. Record set point in Record and Information Books.

3.8. 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. Three (3) hardcopies and one (1) electronic copy 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 Contractor
 11. Commissioning Agent
 12. Dates tests were performed
 13. Certification
 14. Duct Leakage Tests
 15. 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.
- E. The test and balance report shall include a table of contents with numbered pages.

3.9. 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, dampers, 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. Chiller and 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.
10. For air cooled chillers condenser fan speed and kw.
11. Where applicable, electric heat trace operation for chilled water and heating water piping located outside.
12. Test operation of flow switches.

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).

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 Forms:
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. 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. Rated and actual entering and leaving pressure at each hydronic coil.
14. Record carbon dioxide set points and actual readings for exhaust air stream at each ERV and global CO2 sensor.
15. Record the supply fan and exhaust fan maximum hertz/speed and minimum hertz/speed. Provide measurements to ATC subcontractor for fan tracking control.
16. 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.

M. Fan Coil Unit Data Test Forms:

1. Manufacturer.
2. Type.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Water Pressure drops (all coils).
8. Static pressure
9. Test amperage
10. Entering coil conditions (wet bulb and dry bulb).
11. Leaving coil conditions (wet bulb and dry bulb).

12. Water flow rates (all coils)
 13. Test voltage.
 14. Supply return and outside air flow rates.
- N. Condensate Over Flow Switches/Floats Test Forms
1. Manufacturer
 2. Type
 3. Location
 4. Equipment shut down verification
 5. ATC interlock verification
- O. Electric Radiant Heat Panels Test Forms:
1. Manufacturer.
 2. Identification/number.
 3. Location.
 4. Model number.
 5. Design kW and actual kW.
 6. Phase, voltage, amperage.
 7. Test voltage (each phase).
 8. Test amperage (each phase).
 9. Air flow, specified and actual.
 10. Temperature rise, specified and actual.
- P. Single Zone VAV 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 each cooling coil, heat pipe and energy wheel. Dry-bulb temperatures entering and leaving each heating coil.
13. Rated and actual pressure entering/leaving each hydronic coil.
14. Record carbon dioxide set points and actual readings for exhaust air stream at each single zone VAV unit and global CO2 sensor.
15. Record the supply fan and exhaust fan maximum hertz/speed, and minimum hertz/speed. Provide measurements to ATC subcontractor for fan tracking control.
16. Test minimum air flow rate, maximum air flow rate and economizer air flow rate.
17. Submit amperage, air flow rates, RPM, hertz, and static pressure profile in all modes of operation.

Q. Hydronic Unit Heater Test Forms:

1. Manufacturer.
2. Model/Serial #.
3. Location.
4. Design air flow rate and actual air flow rate.
5. Design entering/leaving water temperature and actual entering/leaving water temperature.
6. Design fluid pressure drop and actual fluid pressure drop.
7. Design heating capacity and actual heating capacity in BTU/hr.
8. Actual entering/leaving air temperature.

- R. Packaged Automatic Glycol Feeder Test Forms:
1. Manufacturer, model number, serial number.
 2. All design and actual measured data.
 3. Pump discharge pressure.
 4. Rated and actual voltage, current.
 5. Pressure switch set point pressure.
 6. Test all safeties and alarms.

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DIVISION 23 SECTION 23 06 00
HEATING, VENTILATING, AND AIR CONDITIONING EQUIPMENT
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SECTION 23 06 00 – 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.

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.
- B. Furnish a spare quantity of lime chips for each condensate neutralizer.

1.9. SHORT CIRCUIT CURRENT RATINGS

- A. Unless otherwise noted, all HVAC equipment shall include a nameplate that identifies the short circuit current rating (SCCR). Unless otherwise noted the SCCR rating for all HVAC equipment shall be a minimum of 65 KA.

1.10. PACKAGED EQUIPMENT BACNET CARDS

- A. For all packaged units, furnish and install Bacnet cards for interface to the automatic temperature control system. Map over all Bacnet points and alarms and show on ATC system graphics. All alarms must be identified on ATC graphic.

PART 2. PRODUCTS

2.1. AIR COOLED SCREW CHILLER WITH ACOUSTIC DISCHARGE PLENUM

- A. Provide packaged air cooled "screw" chiller of the size, capacity, and electrical characteristics as shown on the contract drawings. Provide demand limiting feature and interlock with automatic temperature control system.
- B. Chiller shall be Trane Model RTAC, Model YVAA as manufactured by York, Daikin, Carrier, or approved equal. Provide demand limiting feature and interlock with ATC

system.

C. General

1. Operating test shall include operation with water flowing through the cooler. The unit structure shall be heavy-gauge, galvanized steel. All external parts shall be covered with a baked-on powdered paint to withstand 500 hours of salt-spray testing using 5 percent salt-spray solution per ASTM B117 without exhibiting any film breakdown beyond 1/8-inch on each side of a scribed line. (This shall be equivalent to an ASTM D 1654 rating of "6".) The unit shall be shipped with a full operating charge of R-513A, R-32, or R-454B, and required refrigerant oil. All units shall contain multiple refrigerant circuits, each with two (2) compressors, for standby operation. All units shall be designed and constructed in accordance with the applicable sections of the following: ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration; American Society of Mechanical Engineers (ASME) Pressure Vessel Code; National Electrical Code/National Fire Protection Association NFPA 70; U.L. and C.U.L. listed. All units shall be produced at an ISO 9000 registered facility. All units shall be rated in accordance with ARI Standard 550 and shall be certified up to 300 tons in accordance with ARI Standard 590.
2. All schedule capacities are based on 30% propylene glycol.
3. Provide bird screen around compressors, tubes, etc, to prevent bird nesting and vandalism.
4. Provide bird screen around compressors, tubes, etc, to prevent bird nesting and vandalism. Bird screen shall be heavy gauge, welded wire mesh, coated to resist corrosion and factory installed.
5. Furnish chiller with low sound fans, discharge mufflers, and complete compressor enclosure attenuator housings.
6. Install and commission, as shown on the schedules and plans, one factory assembled, charged, and tested air-cooled screw compressor chiller as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD-34 Number Designation and Safety Classification of Refrigerants. Chiller shall include, but is not limited to: a complete system with screw compressors, direct expansion type evaporator, air-cooled condenser, refrigerant lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.
7. Cabinet: External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5 percent salt spray test, yields, minimum ASTM 1654 rating of "6".
8. Chiller shall be delivered to the job site completely assembled and charged with refrigerant and oil by the manufacturer.

D. Compressor and Refrigerant Circuits

1. There shall be a maximum of two compressors per refrigerant circuit. The compressor shall be of the accessible-hermetic rotary twin-screw type. The compressor shall be driven by electrical motor via a gear speed-increaser. The compressor housing shall be made of cast iron, precisely machined to provide minimal clearance of the rotors. The design working pressure shall be 250 PSIG (992 kPa) on the suction side and 450 PSIG (3.1mPa) on the discharge side (hydrostatic tests shall be done at 5 times design working pressure, i.e. 1250 PSIG (5.0 mPa) and 2250 PSIG (15.5 mPa) respectively). The compressor shall be mounted on isolators. The rotors shall be manufactured from hot-rolled steel and use asymmetric profiles. Accurate rotor positioning shall be maintained at all pressure ratios by four separate, cylindrical, roller bearings for radial loads and angular-contact ball bearings for axial loads. The compressor shall contain an internal discharge check-valve to prevent reverse-rotation at shut-down. The compressor shall also contain a 500 watt 115 volt/1 phase/60 Hz) temperature-actuated, immersion heater to prevent refrigerant condensation during shutdown.
2. Capacity Control
 - a. Compressor slide valves shall provide fully modulating capacity control from 100 percent of full load down to 15 percent of chiller full load. The slide valve shall be actuated by oil pressure, controlled by external solenoid valves via the Control Center or approved equal. Additional capacity controls shall be provided as necessary to accomplish sequence of operation.
3. The unit shall contain a minimum of two (2) separate refrigerant circuits. Each shall be constructed of ACR copper tubing with brazed joints and shall include shut-off valve with charging connection, liquid sight glass with moisture indicator, direct acting maximum operating pressure thermal expansion valve, solenoid valve, and filter drier. The entire suction line and liquid line between the expansion valve and the cooler shall be insulated with 1-inch flexible closed cell insulation.
4. Accessible Hermetic Motor
 - a. The compressor motor shall be refrigerant-gas-cooled, 60 Hz motors shall operate at 3,600 RPM. The motor starter shall have U.L. Class "H" insulation. The terminal boxes shall be rain-tight. The hermetic motor shall be high torque, (Wye-Delta) start. The motor shall be equipped with a minimum of three, internal, heat-sensing thermistors.
5. Oil Separation, Lubrication, and Cooling
 - a. An external oil separator with no moving parts shall be provided to minimize oil carry-over for each circuit. Oil separation shall be achieved by the impingement and direction change of the refrigerant gas as its velocity decreases. The oil separators shall be utilized to provide gas/oil separation before the gas enters the air-cooled condenser. The oil separators shall be designed for a maximum working pressure of 450

PSIG (3.1mPa) and are UL/CSA-listed. The oil separator shall include a sight glass. The compressor shall also have integral oil reservoirs located at the rotor bearings to provide lubrication during start-up, coast-down and in the event of power failure. During operation, system-pressure differential shall provide proper oil flow without the need of an oil pump.

6. An external, replaceable-cartridge, 3-micron oil filter shall be provided, with manual isolation stop-valves for ease of servicing.
7. Oil cooling shall be provided by liquid injection to maintain proper oil temperatures for all conditions. A temperature-blending solenoid, controlled via the Millennium Control Center, or equal shall provide consistent oil temperature at all times to assure proper oil viscosity, independent of system conditions.

E. Economizer

1. An economizer shall be included in each circuit to enhance the overall system performance. The refrigerant-to-refrigerant, plate-type economizer shall be constructed of acid-resistant stainless steel. The heat exchanger shall be UL/CSA-listed and designed for 450 PSIG (3.1 mPa). The temperature limits shall be -320 degrees F (-195.6 degrees C) minimum to 365 degrees F (185 degrees C) maximum.

F. Cooler

1. The dual-circuit cooler shall be a direct-expansion type, with refrigerant in the tubes and chilled liquid in the baffled shell. The design working pressure of the cooler shell (liquid side) shall be 150 PSIG (1.0 mPa), and 200 PSIG (1.6 mPa) for the tube (refrigerant side). Refrigerant shall be removable. The cooler shall be equipped with a heater cable covered with 1-½-inch, flexible, closed-cell-foam insulation (K'0.25 maximum) and thermostatically controlled immersion heaters and strip heaters for freeze-up protection to -20 degrees F (-28.9 degrees C) ambient. The cooler shall be constructed and tested in accordance with the applicable sections for the ASME Pressure Vessel Code requirements Section VIII, Division (1). The water connections shall be fully accessible and grooved to accept Victaulic couplings, welded, or flanged.
2. Brazed plate stainless steel heat exchangers shall be UL Listed. Units shall have a water strainer that is factory furnished and installed with blowdown valve.

G. Condenser

1. Coils: The condenser coils shall be constructed of seamless copper tubes, arranged in staggered rows, mechanically expanded into aluminum fins and include an integral subcooling section. The design working pressure of the condenser coil shall be 450 PSIG (3.1 mPa). Provide louvered panels to protect condensers. Provide condenser corrosion protection including flexible dip and baked epoxy coating.
2. Fans: The condenser fans shall be glass-reinforced polypropylene, high-efficiency, airfoil-type, providing vertical air discharge. The fans shall be

directly driven by independent motors and positioned in extended orifices for low sound. The fan guards shall be constructed of heavy-gauge, rust-resistant, PVC-coated steel. Fan blades shall be dynamically and statically balanced for vibration-free operation.

3. Motors: The fan motors shall be Totally Enclosed Air-Over (TEAO), squirrel-cage type, and current-protected. They shall feature ball bearings that are double-sealed and permanently lubricated. Each motor shall have U. L. Class "F" insulation.
4. Fans shall be partitioned to avoid cross circulation.

H. Refrigerant Circuit

1. The unit shall contain a minimum of two independent refrigerant circuits and shall be constructed of copper tubing with brazed joints. The liquid line shall include a shutoff valve with a charging port; sight glass with moisture-indicator; direct-acting maximum-operating-pressure thermal expansion valve; solenoid valve with internal relief; and filter-drier. The entire suction line, and the liquid line between the expansion valve and the cooler, shall be insulated with flexible, closed cell-insulations.
2. Refrigerant shall be R-513A, R-32 or R-454B.

I. Control Center

1. Each unit shall contain a Control Center or approved equal. Control center shall include BACnet protocol. All controls shall be contained within a rain tight/dust tight NEMA 3R (and equivalent to IP55 European standard) cabinet with hinged outer door having positive-acting latches. The center shall contain the "user friendly" and interactive inputs and outputs as follows: LCD display with light-emitting-diode back-lighting for outdoor viewing of data, and input buttons for DISPLAY (temperatures, pressures, etc.). ENTRY (enter/cancel inputs, advance day, change AM/PM), SET POINTS (change), CLOCK (set time and schedule), PRINT (calling up operating and shutdown data), PROGRAM (change inputs for special conditions such as brine chilling, and UNIT ON/OFF).
2. The Control Center or approved equal shall be capable of displaying the following in English or Metric: return and leaving liquid temperature; low leaving-liquid-temperature cutout setting; ambient temperatures (actual outdoor temperature, low and high ambient cutout); suction pressure cutout setting; percent full-load motor current for each phase and the average of all three phases, suction, discharge and oil differential pressures; liquid-pulldown rate-sensitivity adjustment (0.5 degrees F to 5 degrees F (6.3 to 2.8 degrees C) per minute in one-tenth increment); anti-recycle-timer status; slide-valve position (each compressor); superheat status; discharge pressure and current limiting; phase-rotation safety; compressor-run status; no-cooling-load condition; day; date; time: out-of-range message; daily and holiday scheduling of start/stop times; automatic or manual lead/lag status; lead-compressor definition; number of compressor starts and running hours; evaporator heater, fan operation; liquid line solenoid valves; water pump; last fault-shutdown data; number of unloading

steps; chiller pump control for freeze protection, compressor load-and-unload timer status.

3. The standard unit shall include run-signal contacts; automatic pumpdown on start-up and shutdown; alarm contacts; evaporator-pump control; automatic restart after power failure, remote start-stop, high suction and discharge pressure unloading. Three steps of demand load limiting, and remote chilled liquid re-set from an external building automatic system via 4 to 20 Ma or 0 to 10VDC with an interface board.
4. The operating program is stored in a non-volatile memory (EPROM) to eliminate chiller failure due to AC-power failure/battery discharge. Programmed setpoints are retained in lithium-battery-backed RTC memory for 5 years minimum.
5. Provisions shall be included for: a hard copy print-out from a printer (by others) via an RS-232 electrical output; remote water-temperature and current reset.
6. Pressure transducers shall be factory mounted to allow control to sense and display discharge pressure.
7. All controls, setpoints and BACNET attributes shall be fully integrated with ATC system.
8. The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.
9. Shutdown Alarms
 - a. No evaporator water flow (auto restart)
 - b. Sensor failures
 - c. Low evaporator pressure
 - d. Evaporator freeze protection
 - e. High condenser pressure
 - f. Outside ambient temperature (auto-restart)
 - g. Motor protection system
 - h. Phase voltage protection (Optional)
10. Limit Alarms
 - a. Condenser pressure stage down, unloads unit at high discharge pressures.
 - b. Low ambient lockout, shuts off unit at low ambient temperatures.
 - c. Low evaporator pressure hold, holds stage #1 until pressure rises.
 - d. Low evaporator pressure unload, shuts off one compressor.
11. Unit Enable Section
 - a. Enables unit operation from either local keypad, digital input, or BAS.
12. Unit Mode Selection

- a. Selects standard cooling, or test operation mode.
- 13. Analog Inputs:
 - a. Reset of leaving water temperature, 4-20mA.
 - b. Current Limit.
- 14. Digital Inputs
 - a. Unit off switch
 - b. Remote start/stop
 - c. Flow switch
 - d. Motor protection
- 15. Digital Outputs
 - a. Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared.
 - b. Evaporator pump; field wired, starts pump when unit is set to start.
 - c. Chiller pump control for freeze protection. (Sends a signal to ATC system to energize pump flow for freeze protection.)

J. Building Automation System (BAS) Interface

- 1. Factory mounted DDC controller(s) shall support operation on a BACnet® network via one of the data link/physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
- 2. BACnet MS/TP master (Clause 9)
- 3. BACnet IP, (Annex J)
- 4. BACnet ISO 8802-3, (Ethernet)
- 5. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notifications as specified in the unit sequence of operation and the unit points list.
- 6. All communication from the chiller unit control as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

K. Power Panel

- 1. The power panels shall contain the compressor power terminals, compressor motor-starting contactors with three external over-load protection, three additional current transformer sensing on each compressor phase for current monitoring, for protection against under-voltage, over voltage, imbalanced

voltage, single phasing, compressor stall and voltage spikes, and control power supply terminal strip for 115-1-60. The power panel shall contain a 15-amp, 115 volt convenience outlet with Ground Fault Protection.

2. The compressor and fan power wiring shall be routed through U.L. listed, liquid-tight, nonmetallic conduit suitable for outdoor use.
3. Single Point Connection Circuit Breaker: Provide a HACR rated molded case capacity circuit breaker (U.L. Approved). The circuit breaker shall be able to be used as disconnect through the door handle and shall be pre-wired from factory with terminal block connections. The external operator handle shall be lockable.

L. Control Transformer

1. A control transformer shall be factory installed to convert unit power voltage to 115-1-60. Factory mounting shall include primary and secondary wiring between the transformer and the control panel.

M. Tuned Discharge Mufflers

1. Muffler shall be included in each discharge line. It is acoustically tuned to attenuate the predominant frequencies of the gas pulsations for the particular compressor.

N. Sound Attenuation

1. Provide comprehensive sound enhancement package, including, low sound fans and an acoustical blanket shall be furnished on each unit. Fans shall be reduced RPM, 8 pole fan motors with steeper pitch fans.

O. Start-up and Warranty:

1. Provide the services of the chiller manufacturer's factory trained service technician to start the chiller(s). Service shall also provide concurrent training to the Owner's personnel.
2. Provide two (2) year parts and labor warranty with each unit. Provide extended compressor warranty for three (3) additional years.

P. Comprehensive Sound Enhancement Packages (Base Bid):

1. Low sound fans and an acoustical blanket shall be furnished on each unit. Fans shall be reduced RPM, 8 pole fan motors with steeper pitch fans.
2. Sound power levels so as not to exceed the following:

Sound Power Level db re 1 picowatt								
dBa	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz

99	90	98	99	97	94	92	85	80

3. Compressor sound attenuation shall be of the perimeter design to allow ease of removal and access to compressor components.
4. Net chiller capacity shall be maintained as scheduled with the addition of the chiller sound enclosures.

Q. Custom Acoustic Discharge Plenum (Alternate)

1. Provide custom acoustic discharge plenum by Hushcore IS UnitaryPLUS "Silencer Bank" or approved equal.
2. Discharge plenum shall be 54" tall acoustical panel discharge plenum constructed from 4" thick acoustic panels (STC 40). Panels shall have a galvanized finish and (1) end panel shall include a 3'x2' tall service access door.
3. System includes vertical columns with baseplates. System also includes 22 gauge/22 gauge construction HUSH DUCT rectangular low pressure drop silencers (shipped loose) and field installed as required for number of condenser fans. Provide 3"x4" galvanized angles for interior silencer supports (recessed silencers) as well as all hardware required for the installation. Provide anchor bolts as required for installation. Coordinate base structure for chiller with sound enclosure supports.
4. Estimated acoustic performance: 12 dBA. (Reduction).

R. Vibration Isolators

1. Provide level adjusting spring type, 1-inch deflection isolator with mounting brackets for mounting under the unit base. All exterior vibration isolators shall be stainless steel including hardware. As an alternate, vibration isolators may be provided as specified under Section 230548 at contractor's option.

S. Accessories and Options

1. Microprocessor controlled, Factory installed Across-the-Line type compressor motor starters as standard.
2. Power Supply Connection:
 - a. Single Point Connection Circuit Breaker: Provide a HACR rated molded case capacity circuit breaker (U.L. Approved). The circuit breaker shall be able to be used as disconnect through the door handle and shall be pre-wired from factory with terminal block connections. The external operator handle shall be lockable.
 - b. Ground Fault Protection: Factory installed circuit breakers.
 - c. Phase loss protection with under/over voltage protection and with LED indication of the type of fault.

3. Pressure Transducers and Readout Capability
 - a. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
 - b. Suction Pressure Transducers: Permits unit to sense and display suction pressure.
 4. Control Power Transformer: Converts unit power voltage to 120-1-60 (500 VA capacity). Factory mounting includes primary- and secondary-wiring between the transformer and the control panel.
 5. Flow Switch (Factory Mounted): Vapor proof NEMA 4X switch (150 psig), -20 degrees F to 250 degrees F. Thermal dispersion type. Provide additional contacts to allow monitoring on the ATC system. An additional mechanical flow switch shall also be installed in evaporator piping.
 6. Building Automation System (EMS) Reset Interface: Chiller to accept 4 to 20mA, 0 to 10 VDC, or discrete contact closure input to reset the leaving chilled liquid temperature.
 7. Sound Reduction (Factory Mounted): Acoustic Compressor Blankets. Low speed condenser fans and sound attenuation enclosure.
 8. Vibration Isolation (Field Mounted):
 - a. 1 inch deflection spring isolators: level adjusting, spring and cage type isolators for mounting under the unit base rails.
 9. Wye strainers with stainless steel mesh size as required by chiller manufacturer. Furnish with blowdown valve, pipe extension, two Schraeder valves, fittings, and grooved couplings.
- T. Source Quality Control
1. Verification of Performance: Rate chillers according to ARI 550 and up to 200 tons in accordance with ARI Standard 590.
 2. Testing Requirements: Factory test for the following:
 - a. Sound-Power-Level Ratings: According to ARI 370.

2.2. AUTOMATIC GLYCOL MAKEUP SYSTEM

- A. Furnish an automatic glycol feeder to provide consistent operating pressure in the closed loop system by feeding a controlled percentage of glycol solution. Glycol shall be made-up automatically from a pre-mixed solution tank. A low level switch shall prevent pump operation when solution level is too low.
- B. The glycol feeder package to consist of a prewired control unit in a NEMA 1 steel enclosure and a pre-piped flow assembly including a pressure switch, pressure relief valve, 50 gallon polyethylene tank, low level switch, positive displacement pump, and

- pressure gauges. Automatic glycol feed system shall be Pulsafeeder Model GF-1, or approved equal.
- C. Glycol solution tank shall be 50 gallons polyethylene tank with steel supports for mounting the transfer pump below the tank. Provide hinged polyethylene cover, pump suction connection, and drain valve.
 - D. Positive displacement flooded suction pump rated at capacity as scheduled on the contract drawings.
 - E. Provide PVC piping from the tank to the pump with PVC ball valve and steel strainer. Include at discharge a check valve, ball type shutoff valve and pressure relief valve piped back to the solution tank.
 - F. Provide a dolly suitable for transporting 55 gallon drums to the charging station. Dollies shall be suitable for storing a drum in the horizontal position so that the solution may be drained into a transfer pail. Include spring loaded draw valve.
 - G. Provide 5 gallon plastic pail.
 - H. Provide low level switch and dry contacts for monitoring on the ATC system.

2.3. INDUSTRIAL INHIBITED PROPYLENE GLYCOL

- A. Provide a 30 percent by volume (as installed) industrial grade inhibited propylene glycol heat transfer fluid as manufactured by the Dow Chemical Company (Dowfrost HD), Houghton, Interstate Chemical (Intercool P-300) Glycochill Plus or approved equal. The 30 percent solution shall provide freeze protection to 12 degrees F and burst protection to -20 degrees F. The propylene glycol solution as supplied by the manufacturer shall contain corrosion inhibitors specially formulated for cool storage services to keep internal surfaces free from corrosion and fouling and shall include buffers, reserve alkalinity agents, antifoaming additives, and a fluorescent dye to aid in leak detection. The solution shall be easily re-inhibited using specially formulated inhibitor readily available from the field manufacturer. The manufacturer shall provide free propylene glycol yearly solution laboratory analysis. The analysis shall accurately report propylene glycol concentration, freeze point temperature, inhibitor level, alkalinity, particulate and recommended additions of glycol, inhibitor and buffers to ensure twenty-year minimum life. The fluid shall pass the ASTM D-1384 test with less than 0.5 mils penetration per year.
- B. Automotive antifreeze or any solutions containing silicates shall not be acceptable.
- C. Propylene glycol shall be supplied prediluted with deionized water and installed in the specified piping systems.
- D. Provide a Misco Products calibrated hand held refractor meter.
- E. Provide one spare 55 gallon drum of glycol.
- F. Contractor shall chemically clean and flush the completed propylene glycol system. As a minimum, system shall be cleaned with a 1 percent to 2 percent solution of trisodium phosphate in water. Provide temporary bypasses at the ice storage modules for the initial

pressure testing, cleaning and flushing operations. This prevents the transfer of contaminants to the clean tubing in the modules. The system shall be thoroughly flushed using clean water and circulated for a minimum of 72 hours at which time water samples shall be taken by the contractor who shall certify that the system is free of particulate, mil scale, weld scale, solder flux, rust, metal filings, oil, grease, chlorides, sulphates, silicates and other foreign matter that could degrade the propylene glycol. After the system is charged with the approved heat transfer fluid, air shall be eliminated from the system, and the heat transfer fluid shall be circulated for 72 hours through all components. The contractor shall test and adjust the concentration to achieve 30 percent by volume propylene glycol.

- G. Entire system shall conform to EPRI Standard propylene glycol systems 15751.
- H. Flushing period (72 hours) shall be closely monitored to prevent excess heat build-up due to pump heat.

2.4. GLYCOL FEEDER PRESSURE TANK

- A. Provide and install glycol feeder pressure tanks of size, capacity and as indicated on contract drawings. Glycol feeder pressure tanks shall be Therm-X-TROL as manufactured by AMTROL Inc., Flexcon, Wessels, Taco or approved equal. Mount tank as detailed on the drawings.
- B. Glycol feeder pressure tanks shall be specifically designed for use in glycol 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 glycol feed pump 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.

2.5. 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, and similar spaces shall be sparkproof and shall include a phenolic coating on all components exposed to the airstream.

B. In-line Cabinet Fans

1. Furnish and install in-line centrifugal direct drive cabinet fans of the size, capacity, and electrical characteristics as shown on the contract drawings.
2. Duct mounted cabinet fans shall be of the centrifugal, direct drive type. The fan housing shall be constructed of heavy gauge galvanized steel and shall include prepunched mounting brackets. The housing interior shall be lined with 2-inch acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge. The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type. The motor shall be mounted on vibration isolators. The fan wheel(s) shall be of the forward curved centrifugal type, constructed of galvanized steel and dynamically balanced. Fans shall be licensed to bear the AMCA Certified Ratings Seals for sound and air performance and shall be U.L. Listed and C.S.A. approved.
3. Fans shall be complete with backdraft damper, unit mounted solid state speed controller, and plug-in disconnect switch.
4. Duct mounted in-line cabinet fans shall be Model CSP as manufactured by Greenheck, ACME Engineering, Penn Ventilator, Cook or approved equal.

2.6. HOT WATER CONDENSING BOILERS

- A. Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.
- B. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- C. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
- D. Include diagrams for power, signal, and control wiring.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Warranty: Special warranty specified in this Section.
- H. Other Informational Submittals:
 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp

certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

- I. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- J. 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.
- K. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code including ASME CSD-1, amendments, and addenda, latest edition.
- L. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- M. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- N. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- O. The boiler and installation shall comply with all requirements of the local boiler inspector.
- P. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Install concrete, reinforcement, and formwork requirements are specified with concrete.
- Q. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.
- R. Manufacturers: Subject to compliance with contract documents, provide products by one of the following:
 - 1. Lochinvar (Model = Crest)
 - 2. AERCO International
 - 3. Raypack
 - 4. Cleaver Brooks
 - 5. Viessmann

6. Weil McLain
7. Patterson Kelley
8. RBI Boilers
- S. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- T. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber. Type 316 L Stainless steel tubes and tube sheets.
- U. Pressure Vessel: Carbon steel with welded heads and tube connections.
- V. Burner: Natural gas, forced draft with electronic flame safeguard control and flame detector with UV scanner. Interlock flame failure with ATC system.
- W. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 1. Motors: Comply with requirements specified in Division 23, Section "Common Work Results for HVAC."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- X. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- Y. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- Z. Casing:
 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Baked-enamel or Powder-coated protective finish.
 4. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
 5. Combustion-Air Connections: Inlet and vent duct collars.
 6. Mounting base to secure boiler.
 - a. Characteristics and Capacities:
 - i. Heating Medium: Hot water.
 - ii. Design Water Pressure Rating: 160 psig (1100 kPa)

- iii. Safety Relief Valve Setting: As indicated on the Contract Drawings.
 - iv. Refer to contract drawings for additional capacity information.
- AA. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- BB. Aquastat Controllers: Operating, firing rate, and high limit.
- CC. Safety Relief Valve: ASME rated.
- DD. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- EE. Boiler Air Vent: Automatic.
- FF. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
- GG. Flow Switch: Water flow switch to prevent burner operation during low water flow condition.
- HH. Fully testable and manual re-set low water cut-off with manifold fitting. Provide low water cut-off with dry contacts for interfacing with ATC system.
- II. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem. All valves shall be OS&Y type.
- JJ. Supply and return piping connections and accessories up to first OS&Y valves shall be welded, flanged, or screwed.
- KK. Refer to Division 23, Section "Instrumentation and Controls of HVAC and Plumbing Systems."
- LL. Boiler operating controls shall include the following devices and features:
- 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
 - b. Hot water re-set of supply water temperature based on outside air temperature.
- MM. 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.
- NN. 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.
- OO. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- PP. 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.
 6. For three (3) phase units, furnish phase loss protection.
- QQ. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, double wall pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

- RR. Combustion-Air Intake: Complete system, PVC intake, pipe or stainless steel, vent terminal with screen, inlet air coupling, and sealant.
- SS. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- TT. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- UU. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

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. VERTICAL IN-LINE PUMPS

- A. Furnish and install vertical centrifugal in-line single stage pump(s), with capacities and characteristics as shown on the plans. Pumps shall be Taco Model VI, Bell and Gossett, Patterson, Armstrong or approved equal.
- B. Pump volute or casing shall be constructed of class 35 cast iron. The pump shall be fitted with replaceable bronze wear rings, drilled and tapped for gauge ports at both the suction and discharge flanges and for drain port at the bottom of the casing. The pump shall be capable of being serviced without disturbing system piping. Pumps shall be bronze fitted for use in closed systems and all bronze construction in open systems. Furnish pumps with flange supports (typical of 2) for each pump.
- C. The impeller shall be bronze and hydraulically balanced by either back vanes or back wear ring and balancing holes. The impeller shall be dynamically balanced and shall be fitted to the shaft with a key.
- D. The pump shall be close coupled to a NEMA standard JM regreasable high efficiency motor. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The shaft shall be covered with a replaceable bronze shaft sleeve. Motors shall be 1750 rpm. 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 pump curve.
- 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. The 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 5 micron filters in seal flushing line.
- G. The pump seal shall be EPT Ceramic rated to 250 degrees F. Pumps shall be finished in a baked enamel finish designed to resist rusting. Pumps shall be suitable for up to 175 psi

working pressure and up to 250 degrees F water temperature. For pool applications the pump seal shall be Viton-carbon/Ceramic seal with extended flush line and cuno filter rated to 250 degrees F. Pumps shall be finished in a baked enamel finish designed to resist rusting. Pumps shall be suitable for up to 175 psi working pressure and up to 250 degrees F water temperature.

- 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.

2.9. SPLIT COUPLED VERTICAL IN-LINE PUMPS

- A. Furnish and install split-coupled in-line centrifugal pumps with capacities and characteristics as shown on the Contract Drawings. Pumps shall be Series e-805C as manufactured by Bell & Gossett, Taco, Patterson, Armstrong or approved equal.
- B. The pumps shall be a split-coupled, in-line for vertical installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 250°F and 175 PSIG working pressure. Working pressure shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
- C. The pumps shall have a 416 stainless steel shaft that is guided by a carbon graphite lower throttle bushing.
- D. Pump shall be equipped with a Unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal-to-metal drive system to reduce torsional stress on the bellows. The bellows shall be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face.
- E. Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards, ANSI/HI 9.6.4.5-2000. The allowable residual imbalance shall conform to ANSI grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
- F. The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing or the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.
- G. The combination motor bracket and volute coverplate shall be a one-piece unit to ensure concentric alignment of the motor to the pump casing. A carbon steel coupler guard conforming to both ANSI B15.1-2000 and OSHA 1910.219 standards shall be mounted on the motor bracket for safety.
- H. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.

- I. Motors shall be NEMA Premium efficient and shall be the size, voltage, and enclosure called for on the plans. Motors shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.
- J. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved the by Engineer.
- K. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
- L. Pump manufacturer shall be ISO-9001 certified.
- M. Each pump shall be factory tested and name-plated before shipment.
- N. The pump may include an internal stainless steel casing wear rings.
- O. Pumping equipment shall require Hydraulic Institute Level B tests.
- P. Furnish with flange supports (typical of 2) for each pump.
- Q. 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.

2.10. VARIABLE SPEED DRIVES

- A. Provide variable speed drive controllers for Pumps, Equipment, as indicated on contract drawings. Drive shall be subject to the requirements of this section.
- B. ERV variable speed drives shall be factory furnished by ERV unit manufacturer.
- C. The single zone VAV air handling units shall be factory furnished with variable frequency drives for the supply and return air fan.
- D. 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.
- E. The AFC shall be a voltage source type with a PWM output utilizing power transistor semi-conductors.
- F. The AFC together with all options and modifications shall mount within a standard NEMA 1 enclosure or NEMA-4X for exterior installation 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. 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 troubleshoot and test the controller, both energized and de-energized, while operating the bypass mode.
- M. 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.

- N. 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.
- O. The VFC shall carry a full parts and labor warranty for two years from date of substantial completion.
- P. 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.
- Q. 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.
- R. 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.
- S. 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. HYDRAULIC SEPARATORS

- A. Provide and install a chilled water hydraulic separator for use with chillers of the size, dimensions, and capacity as indicated on the contract drawings/schedules. Tank shall be as manufactured by Lochinvar (Model BVU), Cemline, or approved equal.
- B. The hydraulic separator shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII Div. 1, Part U requirements, stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The tank shall be furnished with flanged source (chiller) system connections and flanged load connections for system supply and return. Tank size, piping tapping size and piping tapping quantity shall be as scheduled on contract drawings. Provide relief valve tapping, drain pipe tapping and temperature sensor tappings as scheduled on contract drawings. The tank shall be constructed with a built-in air separator with automatic air vent. Provide 12x16 manway for tank.
- C. The hydraulic separator shall have a working pressure of 125 PSI (at 400 degrees Fahrenheit) and shall be channel iron skid mounted with lifting lugs. The hydraulic separator shall carry a five-year warranty against tank failure resulting from defects in materials or workmanship.

- D. The hydraulic separator shall be constructed with a heavy gauge galvanized steel jacket assembly, primed and pre-painted on both sides with a minimum dry film thickness of 0.70 mills. The hydraulic separator shall be completely encased in a minimum of 2" thick, high density, HCFC free, polyurethane foam insulation to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard.
- E. Tank shall be factory furnished with all inlet, outlet, thermometer, relief-valve, temperature sensor and air vent tappings.
- F. Provide factory furnished and installed A.S.M.E. pressure/ temperature relief valve. Pipe relief valve to nearest floor drain with union on discharge piping.
- G. Mount tank on a 4-inch high housekeeping pad.
- H. Provide factory furnished and installed A.S.M.E. pressure/ temperature relief

2.14. 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.

2.15. DUCTLESS FAN COIL UNITS

- A. General:
 - 1. The supplied product shall be a Johnson Controls, Aeremec, Carrier, Airstream, Multiaqua, or approved equal, four (4) pipe chilled/hot water ceiling cassette unit.
- B. Cases:
 - 1. The unit casing shall manufactured from lightweight galvanized sheet steel with

integral fan mounting rails for added strength. Fire resistant foam insulation (to UL94 VO) shall be fitted internally to provide both thermal and acoustic insulation.

C. Coils:

1. Chilled water units utilize large surface area coils positioned to optimize heat transfer and airflow. Each coil shall be manufactured from refrigeration quality copper tubes with mechanically bonded aluminum fins and shall be circuited from headers to ensure low water pressure drops.

D. Condensate Pump:

1. A condensate pump and check valve shall be fitted to carry water out of the unit and stop water from flowing back into the condensate tray. The pump is shall be fixed to a mounting bracket which can be withdrawn from the side of the chassis and shall incorporate an inspection hole to allow a visual check of the pump during operation. A float switch shall be fitted to stop the cooling action should the pump become blocked or fail.

E. Air Vanes:

1. Air outlet vanes shall designed to prevent condensation from forming. Vanes shall be manually adjustable on the 2 x 2 model units but driven by an electric motor on all other model units. Where fitted, the motorized air vanes can be set to auto sweep or can be stopped in a fixed position. Polystyrene blanking pieces are supplied with Cassette packing so that up to two fascia discharge slots can be blanked off.

F. Fans & Fan Motor:

1. All units shall utilize ECM fans that are statically and dynamically balanced for quiet operation. Fan impellers are made from either aluminum or fire-retardant plastic (UL94 VO) for light weight and corrosion resistant operation. Fans shall be driven by ECM motor allowing good heat dissipation and an increased motor efficiency. Fans shall come complete with thermal overload protection and sealed-for-life lubricated bearings.

G. Step Up Transformer:

1. The unit shall be fitted with an appropriate 115 volt to 230 volt step up transformer.

H. Filter:

1. MERV 10, 2" thick radial pleated disposable cotton and synthetic blend filters. Minimum Efficiency Reporting Value of MERV 10 per ASHRAE standard 52.2.

I. Electro-Mechanical Controls:

1. The unit shall include an electro-mechanical controller that includes the recessing

relays and safety switch for proper operation. The ATC contractor shall field install unit controllers and control valves to fully control and monitor the units operation per the sequence of operations.

J. Options - Factory Installed:

1. Alarm Interlock Relay: The unit shall include a relay for unit failure notification. Normally open contact available for field connection.
2. Start / Stop Terminals: The unit shall include terminals for remote start/stop of the unit. The unit is enabled when contact between the terminals is closed.
3. Hot Water Coil: A hot water heating coil shall be factory fitted in addition to the chilled water coil to provide heating. The coil shall be manufactured from refrigeration quality copper tubes with mechanically bonded aluminum fins.
4. Disconnect Switch: The unit shall be fitted with a power disconnect switch located on the control panel, sized for the full load amperage of the unit to enable the unit to be disconnected from the power supply prior to any maintenance.

K. Junction Box: Units shall have the fan speed switch and optional controls wired to the control box. Furnish all units with factory installed/wired fused disconnect, motor starter, and relay package.

2.16. DUCTED FAN COIL/BLOWER COIL UNITS

- A. Provide and install fan coil/blower coil units of the type, capacity, and electrical characteristics as shown and scheduled on the plans. The units shall be installed in a neat and workmanship like manner in strict accordance with specifications. Fan coil units shall be as manufactured by Daikin (Destiny Series). Fan coil/blower coil units fully equal to the specified manufacturer and those manufactured by York, BCH, Price (Genesis Series), International Environmental Company, and Trane are acceptable provided they meet connection limitations and all requirements. All fan coil/blower coil units shall be U.L. and CSA approved. All units shall be rated in accordance with ARI Industry Standard 440. Conform to ANSI/NFPA 70 code for internal wiring of factory wired equipment.
- B. Basic Unit: The basic unit shall be fabricated of 18 gauge galvanized steel. Interior surfaces of coil section shall be lined with 2 inch coated glass fiber insulation meeting NFPA-90A requirements. The fan and motor assembly shall be easily removable for serviceability.
- C. Cabinet: All models shall be double wall and thermally insulated with 1-inch thick insulation meeting NFPA-90A and U.L.94-5v requirements. The cabinet shall include a solid removable hinged access panel with handles. The supply air connection shall be on the front or top of each unit with a one inch duct collar. The return air connections shall be on the rear or side of each unit with a one inch duct collar. Refer to floor plans for duct arrangement.
- D. Cooling and Heating Sections:

1. Access to coils from drive side or opposite connection side of unit for service and cleaning shall be provided. Coil headers and return bends shall be fully enclosed within unit casing. Coil connections shall be factory sealed with grommet on exterior and gasket sleeve between outer wall and inner liner where each pipe extends through the unit casing to minimize air and condensate leakage.
2. Cooling Coils:
 - a. Cooling performance shall be as specified on the unit schedule.
 - b. Water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
 - c. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.
 - d. Drainpan shall be constructed from stainless steel, pitched and sloped in direction of airflow to drain connection to allow for condensate drainage. Drainpan shall be positioned above 1" thick insulated double wall panel. Condensate drain connections shall be provided on both sides of drain pan. Secondary drain connection shall be provided.
 - e. Coil casing shall be constructed of Galvanized steel.
3. Water Heating Coil:
 - a. Heating performance shall be as specified on the unit schedule.
 - b. Hot water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 - c. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.

E. Supply Fan:

1. The supply fan shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
2. Fan and motor assembly shall be mounted on vibration type isolators inside cabinetry.
3. Units shall be certified in accordance with the central station air handling units certification program that is based on ARI Standard 430.

F. Bearings and Drives:

1. Basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.
2. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
3. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves selected so required RPM is obtained with sheaves set at mid-position and rated based on motor horsepower. Contractor to furnish fixed sheaves at final RPM as determined by balancing contractor.

G. Electrical:

1. Motor shall be a high efficiency open drip-proof type and must meet EPA minimum motor efficiency standards (applicable only to 1HP motors and larger). Electrical characteristics shall be as shown on the schedule.
2. A junction box shall be furnished and mounted by fan manufacturer for field power connection to motor.

H. Junction Box: Furnish all units with factory installed/wired fused disconnect, motor starter, and relay package.

I. Fans: Fans shall be of the centrifugal, forward-curved, double width, double inlet, corrosion resistant type. Fan wheels shall be belt driven and statically and dynamically balanced. Fan wheels shall be painted or galvanized, and housings shall be galvanized steel. Provide adjustable sheaves for fan. Furnish spare set of belts.

J. Drain Pan: Units shall have a drain pan fabricated of 304 stainless steel. Pans shall be insulated with closed cell, polyurethane, sprayed-on foam. Ceiling models shall be provided with an auxiliary drain pan of galvanized steel with a 1-inch MPT drain connection. Steel sleeved auxiliary drain pans shall be provided to permit piping through the auxiliary drain pan. Provide a positively sloped, easily removable non-corrosive drain pan under cooling coils according to ASHRAE 62-89R. Drain pans shall be easily removable without disconnecting piping, wiring or unit removal.

- K. Filters: All units shall be provided with filter return grilles.
- L. The ATC controls contractor shall furnish the terminal control unit controller for installation on each fan coil/blower coil unit by the unit manufacturer. These devices shall be delivered to the unit manufacturer's factory in sufficient time for the manufacturer to meet their schedule obligations. The relay for fan shall be provided by the unit manufacturer who shall also provide the interlock wiring between the relays and the DDC control unit. The unit manufacturer shall also provide a 24 VAC power source at each terminal unit. The cost of factory mounting, wiring, enclosure to meet local code and any factory testing and programming of the terminal control unit shall be included by the fan coil unit manufacturer.
- M. All fan coil/blower coil units shall be sound tested using a qualified reverberant room per ARI Standard 350-82.

2.17. EXTERIOR EQUIPMENT/DUCT SUPPORT

- A. Exterior Equipment Supports shall be Pate Model ES suitable for roof construction. Equipment supports shall be constructed of 18 gauge galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer counterflashing and lag screws. Units shall be internally reinforced. Minimum height shall be 12-inches above the finished roof or as shown on the detail(s) on the drawing(s).

2.18. 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, RTS, or approved equal.

2.19. 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, Kurita, 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. Water Treatment shall be conducted for each phase prior to substantial completion of each phase. 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 glycol systems, chilled water system, and 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, filters and testing during the guarantee period, and provide all required test kits.
- D. Contractor shall maintain the following conditions in each system:

SYSTEMS	Chiller Water System	Hot Water System
ph	8.0 to 10.5	8.0 to 10.5
Inhibitor for Scale & Corrosion Cycles	---	---
Cycles*	---	---
Organic Growth	---	---
Buffered Nitrate	550 ppm	1000 ppm to 180 degrees F 2000 ppm to 180 degrees F
Chromate (Low)		
Molybdate	50 to 100 ppm	100 to 150 ppm
Sulfite	---	---
Sodium Nitrite	500 to 1000 PPM	1000 to 1500 PPM
Corrosion Inhibitor	50 to 100 PPM (as Molybdate) or 1000 to 1500 PPM sodium Nitrite	100 to 150 (as Molybdate)
*Actual cycles of concentration to be determined from analysis of make-up water.		
Use Inhibited antifreeze supplied 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. After chemical cleaning is satisfactorily complete, open the inlet and outlet valves to each coil and close the bypass valves. Also, clean all strainers.
- H. Where glycol is specified or used, additional corrosion inhibitors should not be added without consulting the glycol manufacturer. The boilers shall be fired, maintaining a slow, rolling boil and preventing steam pressure from building during the process, while the surface of the water is continuously skimmed to remove impurities, the boiler manufacturer's recommended procedure shall be followed.
- I. Before adding cleaned chemicals to the closed system, all coils should be isolated by closing the inlet and outlet valves by opening the bypass valves. Also clean all strainers.

2.20. ENERGY RECOVERY VENTILATOR

- A. Provide and install ERV's (Energy Recovery Ventilators) as shown on contract drawings. ERV's shall be Model EnergyPack as manufactured by Venmar, Aaon, Innovent, VTS, or approved equal.
 - 1. Energy Recovery Ventilator shall be as manufactured by Venmar or approved equal provided all specifications are met. Venmar Model EnergyPack 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.

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 interior mounting.
3. Unit casing to be insulated with minimum 2 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. Energy recovery device shall be provided with a rotation sensor for the enthalpy wheel. The rotation sensor shall be an inductive proximity motion detector. The rotation sensor shall be interlocked with ATC system to provide rotation status of enthalpy wheel.

B. Energy Recovery Ventilators

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 referenced to the energy recovery wheel.
2. Motors shall be energy efficient, inverter duty 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 fused disconnect switch, variable speed drives, control circuit fusing, control transformer for 24 VAC circuit and motor starters.
4. Chilled water and hot water coils shall be factory tested and rated in accordance with ARI 410. Coils shall have copper tubes with permanently expanded aluminum fins, 12 fins per inch or less.
5. Dehumidifier heat pipe shall precool the air leaving the wheel and reheat the air leaving the cooling coil in a wrap-around configuration. Both heat exchangers shall be inside and integral to the equipment cabinet. Coils shall have copper tubes with permanently expanded aluminum fins, 12 fins per inch or less. Heat transfer fluid shall be classified as Safety Group A1 in BDR/ASHRAE Std. 15-1989R.
6. Energy recovery ventilators housings shall be factory primed and painted in color as selected by Architect.
7. Both the supply and exhaust air streams shall be filtered to protect the enthalpy wheel. Furnish and install MERV 13 pleated filters, filter racks and access panels. Provide one (1) set of additional filter media to Owner for each unit.
8. Furnish and install ERV wheel rotation sensor.
9. Refer to Division 23 Section, "Common Work Results for HVAC" for VFD motor bearing protective rings.

C. Demand Control Ventilation Components:

1. Energy recovery ventilator fans shall be controlled by a variable frequency drive, as manufactured by Yaskawa or approved equal. 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 location) and interlocked with ERV and demand controlled ventilation.

3. Furnish each energy recovery ventilator with the following:
 - a. Supply air fan variable frequency drive.
 - b. Exhaust air fan variable frequency drive.
 - c. Protective circuits.
 - d. All motor operated dampers and actuators.
 - e. Outside air flow monitoring stations.
 - f. All other unit and space sensors/control, control wiring shall be furnished under Division 23 Section "Instrumentation and Controls for HVAC and Plumbing Systems".
4. The CO2 sensors shall modulate air flow rates from minimum to maximum based on CO2 measurement and reset schedule. Coordinate with ATC Subcontractor.

D. Air Controller

1. Controller shall be furnished and installed by the ATC subcontractor.
2. Controller
 - a. 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 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.

- E. 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 link type belts for each belt drive fan in energy recovery ventilator.
 - 4. Wheel Belts: Furnish one set of belts for each belt driven energy wheel.
- F. 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.

2.21. SINGLE ZONE VAV UNIT

- A. Provide and install single zone VAV unit with integral energy recovery wheels as shown on contract drawings. Single zone VAV unit with integral energy recovery wheels shall be Venmar V3, Aeon Model V3, Addison, Trane, Annexaire, VTS, 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 waterproof adhesive and permanent mechanical fasteners.
 - 4. All components shall be easily accessible through removable hinged doors for both return fan, supply fan, filter, refrigerant components, enthalpy wheel, cooling coil, 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".

6. Furnish and install motor bearing protective rings at all variable frequency drive motors. Refer to Division 23 Section, "Common Work Results for HVAC".

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. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be inverter duty 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 shall be filtered prior to cooling coil. Furnish and install MERV-13 pleated filters, filter racks and access panels. Provide one (1) set of additional filter media to Owner for each unit.
5. Unit shall include 2 inch thick, pleated panel outside air and return air filters with MERV rating of 13, upstream of the wheels. If unit is not provided with integral filter as specified, duct mounted filter housings shall be provided and designed to maximum of 500 fpm velocity and clean filter pressure drop of 0.35 inches w.g.
6. Furnish relief air outlet and outside air inlet with flanged duct connections and field installed flexible duct connections.
7. Furnish and install energy recovery wheel bypass dampers.

C. Chilled Water Cooling 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 single serpentine circuitry, 8 rows, 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.

D. Heating Water Heating Coil

1. Furnish each unit with an insulated, stainless steel IAQ drain pan under the coil extending past the coil to ensure condensate retention.
2. Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
3. 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.
4. Coil shall have half serpentine circuitry, 1 row and 12 fins per inch.
5. 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.
6. Control valves shall be field supplied and field installed.
7. Coils shall be located as indicated on Contract Documents.

E. 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.

F. 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".

G. 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.

H. 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 relative 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.

I. Air Flow Monitoring Station (Field Installed in Ductwork)

- 1. Install air flow monitoring station in minimum 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.

J. Air Controller

- 1. Controller shall be furnished and installed by the ATC subcontractor.
- 2. Controller
 - a. 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 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.

K. 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.

L. Sequence of Operation

- 1. Refer to Division 23 Section, "Instrumentation and Controls of HVAC and Plumbing Systems" for sequences of operation.

M. Warranty

- 1. Furnish unit with two (2) year parts and labor warranty.

2.22. HYDRONIC SYSTEM FLUID FILTER HOUSINGS AND FILTERS

- A. Furnish and install Adey or approved equal magnetic and non-magnetic side stream filters with filter housings.

- B. Standard of acceptance: ADEY® MagnaClean® (model CMX Nano 1", or Midi 2" as scheduled on the contract drawings).
- C. The magnetic and non-magnetic filter shall be a side-stream filter.
- D. The magnetic and non-magnetic filter shall come with High Power, NdFeB, neodymium magnets, 5-50-micron superior spun-bonded cartridge filters, and 5-50-micron needlefelt bag filters. Furnish a 4-pack of 5-micron, 10-micron, 20-micron, and 50-micron filters in addition to spare filters.
- E. The magnetic and non-magnetic filter shall provide adaptive filtration: magnetic and non-magnetic combined.
- F. The magnetic and non-magnetic filter body shall be made of 316L stainless steel with a 304 stainless clamp assembly.
- G. The magnetic and non-magnetic filter shall be supplied with an automatic air-vent. This and the needlefelt bag filters shall promote air separation from the system water.
- H. The magnetic filter magnets should be removeable to facilitate routine cleaning/servicing.
- I. The magnetic and non-magnetic filter shall be rated for 145 psi (10 bar) maximum working pressure.
- J. The magnetic and non-magnetic filter shall have a temperature rating of 14°F to 302°F.
- K. The magnetic and non-magnetic filter shall have versatile installation options: Floor-standing and supported pipe clip options for easier installation & servicing.
- L. The magnetic and non-magnetic filter shall be supplied with EPDM seals.
- M. The magnetic filter shall include a threaded blow down connection to allow for magnetite and debris to be regularly cleaned out of the unit. Furnish adapters to convert factory fittings to NPT fittings.
- N. Furnish the filter housing and filters with the following Magnetic Dirt Filters Accessories:
 - 1. Magnetic Thermal Jacket
 - 2. Thermal Jacket
 - 3. Cartridge filters (5-50-micron)
 - 4. Needlefelt bag filters (5-50-micron)

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 minimum clearances shall be provided per the State 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. Furnish and installed lintels as required.
- J. Arrange for equipment such as boilers, air handling units, energy recovery units, heat pumps, and single zone VAV units 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 owner's 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, troubleshooting 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. CHILLER INSTALLATION REQUIREMENTS

- A. Align chiller package on steel or concrete foundations as indicated. Adjust and level chiller.
- B. Arrange chiller piping for easy dismantling to permit heat exchanger and tube cleaning.
- C. Supply initial charge of refrigerant and oil as required.
- D. Comb out fins on air cooled chillers where deformed or bent. Replace or repair broken fins.
- E. Install chillers according to manufacturer's written instructions. Comply with manufacturer's requirements for rigging and handling chiller.
- F. Install chillers plumb and level, and anchor. Anchor housekeeping pads to building floor. Anchor chiller and vibration isolators to housekeeping pad.
- G. Install vibration isolators according to isolator manufacturer's written instructions.
- H. Maintain manufacturer's recommended clearances for service and maintenance.
- I. Install piping connections maintaining clearances for service and maintenance of chillers.
- J. Manufacturer's Field Service: Provide services of a factory authorized service

representative to supervise field assembly of components and installation of chillers, including piping and electrical connections, and to report results in writing.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- K. Touch up scratches in unfinished surfaces to restore corrosion resistance.
- L. Touch up scratches in finished surfaces to restore finish.
- M. Provide services of a factory trained service technician to start chiller and train Owner on the chiller operation.
- N. Interlock chiller with automatic temperature control system. Coordinate requirements with automatic temperature control contactor.
- O. Install, wire, and interlock fluid flow switch. Interface with automatic temperature control system.
- P. Install flexible connectors, valves, fittings, thermostats, gauges, balance valves, strainers, Pete's Plugs, flow switches, DP sensors, etc. as indicated on flow diagram.
- Q. Test flow switches.
- R. Install manufactured supplied strainer in the chilled water return line at the evaporator inlet. Strainer shall be maximum mesh opening size per chiller manufacturer.
- S. Install vent and drain piping adjacent to evaporator per manufacturer's requirements.
- T. Interlock chiller pump freeze protection control signal with BAS system.

3.7. 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.

3.8. 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. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fans have been test run under operation.
- E. Provide sheave required for final air balance.
- F. Install fans according to manufacturer's written instructions.
- G. Adjust damper linkages for proper damper operation.
- H. Adjust belt tension.
- I. Lubricate bearings.
- J. Replace fan and motor pulleys and belts as required to achieve design conditions.
- K. 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.

3.9. BOILER INSTALLATION REQUIREMENTS

- A. Install boilers in accordance with NFPA-54, NPFA-31, Boiler and Pressure Vessel Safety Act including ASME CSD-1, Amendments and Addenda, latest edition, 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 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 by the Boiler Manufacturer. Furnish and install main gas shut-off valve for each boiler not more than 60 inches above the finished floor.
- FF. Connect hot-water piping to supply- and return-boiler tapplings 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, condensate piping, condensate neutralizers, roof curbs, cleanouts, and combustion-air intake.
2. Connect full size to boiler connections.
3. For condensing boilers connect flue and combustion air ducts full size to 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.

3.10. 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 and split coupled vertical in-line 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 a Laser for all pumps. Alignment by straight edge across the pump couplings shall not be acceptable. Submit laser pump shaft alignment results to Engineer for review and insert a copy in the Operation and Maintenance Manuals.
- E. Install close coupled and base mounted pumps on concrete housekeeping pads, with anchor bolts, set and level, and grout in place. Install split coupled vertical in-line pumps on upper floor as detailed. 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 tapplings. 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. Install flange supports for vertical in-line pumps and maintain clear space above for future motor replacement.
- 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.

3.11. HYDRONIC EQUIPMENT AND SPECIALTIES 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. Perform test determining strength of antifreeze and water solution and submit written test results. At Project completion close the make-up water valve train and open the glycol

feeder valve train and turn on glycol feeder to prevent dilution of the antifreeze concentration in the system.

- L. Install equipment exposed to finished area after walls and ceiling are finished and painted. Avoid damage.
- M. Protection: Provide finished cabinet units with protective covers during balance of construction.
- N. 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.
- O. Testing: After installing and connecting units, demonstrate product capability and compliance with requirements.
- P. Remove and replace malfunctioning units with new units and retest.

3.12. INCREMENTAL EQUIPMENT INSTALLATION REQUIREMENTS

- A. Coordinate installation of all incremental units (fan coil units) with architectural and electrical work.
- B. Fan-coil Units: Install as indicated. Coordinate to assure correct recess size for recessed units.
- C. Units with Cooling Coils: connect drain pan to condensate drain
- D. Coordinate cover openings for all thru-the-wall units with architectural work. Coordinate installation of wall sleeves in finished wall assembly; seal and weather proof.
- E. Vacuum out all units and replace filters prior to turning over the same to the owner.
- F. Electrical: Connect units to wiring systems and to ground as indicated and instructed by manufacturer.
- G. 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.
- H. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- I. Lubricate bearings on fan.
- J. Check fan-wheel rotation for correct direction without vibration and binding.
- K. Start unit according to manufacturer's written instructions.

1. Complete manufacturer's startup checks.
- L. After starting and performance test, change filters.
- M. Prior to installing all fan coil units provide mock-up for 1 ductless unit and 1 ducted unit. Installation shall be reviewed by Owner's Mechanical Inspector and Engineer of Record. Provide three (3) days notice.

3.13. WATER TREATMENT INSTALLATION REQUIREMENTS

- A. Systems shall be operational, filled, started, flushed, and vented prior to cleaning. Use water meter to record capacity in each system. All strainers shall be pulled and cleaned.
- 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 four (4) hours minimum. Drain completely and refill. Where indicated add antifreeze.
- 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 and submit concentration at substantial completion.

3.14. 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 air flow monitoring stations as indicated on the contract drawings.
- 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. Verify sequence of operation.
 5. Record fluid temperatures, fluid pressure drops, and flow rates.
 6. Verify and record minimum and maximum air flow rates for the supply and exhaust air fan.
 7. Verify and record the minimum and maximum supply/exhaust fan speeds/ hertz and incorporate into the fan tracking sequence of operation.
 8. Test A/C condensate overflow safety switch.
 9. Test flow switches.
 10. 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.

3.15. FILTRATION EQUIPMENT INSTALLATION REQUIREMENTS

- A. Duct mounted filter housings shall be supported independent of adjacent ductwork. Hang filter housings using galvanized steel rods.
- B. Where filter housing are not factory insulated, externally insulate to prevent surface condensation.
- C. Install static pressure gauges, tubing, vents, etc., across all filter banks.
- D. Transition ductwork to filter housings as indicated on drawings.
- E. Where indicated, field test all filters in an installed condition.
- F. Install air cleaning devices in accordance with manufacturers instructions.
- G. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- H. Do not operate fan system until filters are in place. Replace temporary filters used during construction and testing, with clean set.
- I. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- J. Coordinate filter installations with duct and air handling unit installations.
- K. After completing system installation and testing, adjusting, and balancing air handling and air distribution systems, clean filter housings and install new filter media.

3.16. CHILLED WATER HYDRAULIC SEPARATOR

- A. Install tank level and plumb on concrete pad.
- B. Arrange piping for easy tank replacement.
- C. Install automatic air vent and pipe discharge to a floor drain.
- D. Field insulate and jacket tank as specified.
- E. Install flange and/or union connections at all taps, openings and fittings.
- F. Install drain valve consisting of a tee fitting and $\frac{3}{4}$ inch ball valved pipe to a floor drain.
- G. Where required fill tank with glycol or treated water after flushing with fresh water.
- H. Install relief valve and pipe discharge with union to a floor drain.

3.17. SINGLE ZONE VAV UNITS INSTALLATION REQUIREMENTS

- A. Examine areas and conditions for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of single zone VAV units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine piping and electric rough installations for single zone VAV units to verify actual locations of piping connections before installation.
- C. Install single zone VAV 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 hot water coil, chilled water coil, with unions, shutoff valves, control valve, flow meter fittings, and autoflow valves.
 - 2. Connect cooling coil drain pan to nearest indirect waste connection, roof drain, air conditioning condensate pump or as indicated.
- F. Duct Connections: Connect supply, return, exhaust and outside air ducts to single zone VAV 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. Connect low voltage safety switch wiring to units where air conditioning condensate pumps are indicated.
- I. 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.
- J. Replace filters used during construction. Seal all return air ducts to filter racks. Seal air tight all filter racks.
- K. 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 refrigerant pressures, air flow rates, 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.
- L. 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.
- M. Maintain minimum of 24 inches clear space at unit filter access. Provide manufacturer required clearances for service at ATC control panel, fan section, compressor section and electrical section. Maintain sufficient clear space below units to allow lowering and raising of units in the future.
- N. All single zone VAV 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.
- O. 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.
- P. Install and interlock space CO2 and relative humidity sensors.
- Q. Install and interlock outside air flow monitoring station and exhaust air flow monitoring station.
- R. 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. Verify and record the minimum and maximum supply/exhaust fan speeds/ hertz and incorporate into the fan tracking sequence of operation.
- S. Install and interlock outside air flow monitoring station. Interlock with ATC system.

- T. Install and interlock exhaust air flow monitoring station. Interlock with exhaust fan variable frequency drive.
- U. Install CO2 sensor/control/interlock wiring to variable frequency drives and to ATC system.
- V. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- W. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
- X. Install piping adjacent to machine to allow service and maintenance.
- Y. Condensate drain piping: Conform to applicable requirements of Division 23 Section, HVAC Piping, Fittings, & Valves. Pipe as indicated on contract drawings.
- Z. Electrical: Conform to applicable requirements of Division 26 Sections.
- AA. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.18. HYDRONIC SYSTEM FLUID FILTER HOUSINGS AND FILTERS INSTALLATION REQUIREMENTS

- A. Install chilled water and heating water filter housing and filters per the manufacturer's requirements.
- B. Install filter housing level and plumb on a concrete pad.
- C. Arrange piping for easy filter housing replacement and to accommodate the closure system.
- D. Install automatic air vent and pipe to discharge to a floor drain.
- E. Field insulate and jacket the filter housing.
- F. Install flange and/or union connections at all taps, openings, and drain connections.
- G. Install drain valve consisting of a tee fitting and ball valve piped to a floor drain.
- H. Install filters in increments and furnish a complete set of spare filters.
- I. Install 3-valve bypass arrangement as detailed on the contract drawings.
- J. Install relief valve and pipe discharge with union to a floor drain.
- K. Install autoflow valve and venturi flow meter as detailed on the contract drawings. Test and balance flow rate.
- L. Test and record inlet, outlet, and differential pressure at design flow rate.

- M. Once the free-flowing magnetic material capture is greatly reduced, the cartridge filters shall be introduced. The first filter shall be the 50-micron filter and working down to the 5-micron filters including intermediate steps using 10-micron filters and 20-micron filters. System should be cleaned to the 5-micron filter stage prior to substantial completion.

END OF SECTION

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HVAC INSULATION
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SECTION 23 07 01 – 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.

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. Indoor pipe insulation shall be ASJ Max with SSL-II closure system pipe insulation as manufactured by Owens Corning or approved equal. Pipe insulation shall be composed of heavy density fiberglass insulation with an organic binder. The insulation shall include a white, factory jacketed, resilient, tough, soil resistant polymer facing that matches standard

PVD fitting covers. Furnish all accessories and matching butt joints sealing tape for system closure. Insulation shall be suitable for operating temperatures between 32 degrees Fahrenheit and 220 degrees Fahrenheit. Flame spread rating of 25 or less, and smoke development rating of 50 or less to comply with building codes for installation in return air plenums. The maximum thermal conductivity (K-value) at a mean temperature of 50 shall be .22 BTU-in/hr-Ft²-degree Fahrenheit.

- E. 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
- F. 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.
- G. 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.
- H. 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.

- I. All disturbed piping insulation in existing areas shall be re-insulated with insulation type, density, and thickness as specified for new piping. Insulation damaged due to new work and demolition only shall be replaced unless otherwise noted.
- J. On cold systems such as refrigerant piping, chilled water piping, cooling coil drain piping, glycol 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.
- K. 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.
- L. 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
Automatic Glycol Feeder Piping	1-inch thickness
Chilled Water Piping 2 ½-inches & Larger	2-inch thickness
Chilled Water Piping 2-inches & Smaller	2-inch thickness
All Branch Runouts to Unit Heaters	½-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	1-inch thickness
Piping within Fan Coil Unit Enclosures	½-inch thickness
Pumped Condensate Piping	1-inch thickness
Boiler/Water Heater Combustion Air Intake Pipes/Ducts	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. Chilled Water Pump and Hot Water Pump Bodies.
 2. Air Separators.
 3. Expansion Tanks/Pressure Tanks.
 4. Chiller Heads.
 5. Chemical Feed Tanks.
 6. All Pump Volute 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. 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, heat pumps, single zone VAV unit 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, etc. 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 disturbed ductwork insulation in existing areas shall be re-insulated with insulation type and thickness as specified for new ductwork. Duct insulation damaged due to installation of new work and demolition only shall be replaced.
- 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.
- K. Clean, seal, and insulate all existing ductwork. Insulate and jacket all existing ductwork.

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, and mechanical joints.
- 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, drain valves, 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.
 - 5. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat trace. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
 - 6. Indoor piping shall be ASJ max with SSL-II closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.
 - 7. Exterior above ground piping shall be insulated with ASJ max SSL-II closure system insulation. Fiberglass insulation with aluminum jacketing shall be utilized for exterior above ground applications. Seal all aluminum jacketing laps with 1/8" bead of metal jacketing sealant to prevent water entry.
 - 8. All floor drain piping that is indicated to receive A/C condensate shall be fully insulated to prevent condensation.
- 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 24 inches (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, storage rooms, janitor closets, IDF rooms, fire pump rooms, and 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

DIVISION 23 SECTION 23 09 00
INSTRUMENTATION AND CONTROLS OF HVAC AND PLUMBING SYSTEMS
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INSTRUMENTATION & CONTROLS OF HVAC & PLUMBING SYSTEMS GIPE ASSOCIATES, INC. (GAI)
23 09 00 - TOC GAI WORK ORDER #24008.B

SECTION 23 09 00 - INSTRUMENTATION AND CONTROLS OF HVAC AND PLUMBING SYSTEMS

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 as installed by Albireo Energy, Johnson Controls (Metasys), Johnson Controls FX (Facility Explorer) as installed by Modern Controls, Honeywell, Siemens, Automated Logic Corporation, Reliable Controls, Schneider Electric as installed by Tri-M, 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 all equipment 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, contactors, 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. Airflow Monitoring Stations
 - 2. Automatic Glycol Feeder
 - 3. Boilers
 - 4. Building Facilities
 - 5. Carbon Dioxide Sensors
 - 6. Combustion Air (Existing Domestic Water Heater)
 - 7. Chilled Water Systems
 - 8. Condensate Overflow Safety Switches
 - 9. Control Valves
 - 10. Differential Bypass Valves Transmitters
 - 11. Duct Detector Fan Interlocks
 - 12. Economizer Systems
 - 13. Energy Recovery Ventilators
 - 14. Electric Radiant Heat Panels
 - 15. Fan Coil Units.
 - 16. Flow Measuring Stations
 - 17. Flow Switches
 - 18. General Exhaust Systems
 - 19. Glycol Feed Systems
 - 20. Heat Pipes

21. Heating System
 22. High Temperature Alarms
 23. Hot Water Coils
 24. Mechanical Room Heat and Ventilation Control
 25. Miscellaneous interlocks required for gas systems, ventilation systems, etc.
 26. Minimum flow provision control valve and interlocks.
 27. Plumbing Systems
 28. Pumps
 29. Relief Air Dampers
 30. Relative Humidity/Temperature Sensors
 31. Sensors (i.e., temperature, relative humidity, CO₂, dewpoint temperature etc.)
 32. Single Zone VAV Units
 33. Static Pressure Controllers
 34. Unit Heater
 35. Variable Speed Drives
 36. Ventilation Systems
 37. Water Heater Combustion Air Damper
- 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: Main tracking/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 2 deg F (1.0 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. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).

- m. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
- n. Carbon Dioxide: Plus or minus 50 ppm.
- o. 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 temperature sensors, relative humidity sensors, CO₂ sensors, dewpoint temperature sensors, 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, 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, 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. 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.
- B. 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.

- C. Refer to Contract Drawings for sequences of operations, control diagrams, and points lists.
- 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 fans, pumps, heating systems, boilers, chillers, switches, dampers, energy recovery ventilators, ductless units, static pressure controllers, single zone VAV units, flow measuring stations, airflow monitoring stations, 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. All software and hardware upgrades shall be included in two (2) year warranty period.
- B. Software license agreement shall not apply on projects where existing ATC system is being extended.
- C. Minimum of four (4) software license seats shall be provided. Storage of all software shall be coordinated with the Caesar Rodney School District's IT Manager.

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 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 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 8 hours. 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, with at least seven days' advance notice.
 - 6. Control Contractor shall also attend and participate in separate HVAC equipment systems training in addition to ATC training.

1.13. ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

1.14. CAESAR RODNEY SCHOOL DISTRICT 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 school. 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, relative 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 and the quantity of electric heat stages shall be displayed on the Computer Graphics.
10. The exact space temperature set points, relative 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 relative humidity 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. For the chilled water system and heating water system provide a single command on the control system to allow all control valves to be manually opened for balancing by activating a single command.
15. All equipment shall be labeled with name of equipment, area served, and area location (room name/number).
16. Scheduling of HVAC equipment/zones shall be such that for afterhours use the ATC system shall allow a temporary override of the pre-set occupied/unoccupied schedule by zone and for specific equipment in a zone. This must allow the school staff the ability to operate as few or many zones as desired without operating entire portions of the building.
17. Provide “Loss of Heat” monitoring and alarm on ATC system if any space temperature sensor in the building drops below 50 degrees Fahrenheit

(Adjustable).

18. Provide additional software package and license so that Owner can install software on Owner provided laptop. Assist owner with installation of software.
19. For boilers, the percent output and firing mode shall be displayed on the computer graphic.
20. Provide a “demand toggle control” switch on ATC system to automatically reduce HVAC electric demand (power) by automatically modifying setpoints to pre-determined values. Coordinate pre-determined setpoint values with Owner and document in the As-Built Documents.
21. Scheduling of HVAC equipment/zones shall be such that for afterhours use the ATC system shall allow a temporary override of the pre-set occupied/unoccupied schedule by zone and for specific equipment in a zone. This must allow the Caesar Rodney School District the ability to operate as few or many zones as desired without operating entire portions of the building.
22. Alarms shall be delayed during optimal start stop to avoid nuisance alarm triggers.
23. Global unoccupied setpoints shall be 70 degrees F in heating mode and 74 degrees F in cooling mode. Coordinate/confirm with Owner all setpoints.
24. Position of all H-O-A switches and other switches shall be reported on ATC graphic with equipment.
25. All text alarms shall clearly identify what they are within the body of the text. i.e. “freeze protection pump failure”, “ERV XX-“, “Duct smoke detector trip”, etc. Coordinate all text alarms and verbiage with Owner.
26. A maximum of four (4) controllers shall be allowed to be installed in an enclosure. All controllers shall be installed to allow proper access for service, maintenance, and modifications.

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 relative humidity.
 - c. Outside Air CO₂ level in ppm.
 - d. Chilled water supply temperature
 - e. Chilled water return temperature.
 - f. Heating water supply temperature
 - g. Heating water return temperature.

- h. All ventilation fan speeds where variable frequency drives are specified.
- i. Outside air carbon dioxide level.
- j. All ventilation fan amperage where variable frequency drives are specified.
- k. All pump or fan speeds where variable frequency drives are specified.
- l. All pump amperage's where variable frequency drives are specified.
- m. All fan amperages where variable speed fans are indicated. Graphic shall also indicate area of building served by each item of equipment.
- n. 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 school is cancelled.
 - ii. System shall also be capable of individual scheduling of equipment as specified or all can be globally modified at once.
- o. 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.
- p. 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. 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.
- F. 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. TAC Controls by Schneider Electric
 - g. Siemens P1/P2 Serial
 - 2. Control networks shall provide either “Peer-to-Peer,” Main-Tracking, 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 (main or tracking) that will communicate on the BACnet

MS/TP Bus.

6. The Conformance Statements shall be submitted with the BAS Submittals.

G. 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.

H. 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 Edge Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance 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). Dual Core Processor.
- d. RAM:
 - i. Capacity: 16GB.
 - 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. Two (2) Network Interface Cards: Include cards 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.
- t. Uninterruptable Power Supply.

I. 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. Trend data shall be available for a minimum of twelve (12) months.
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.

J. 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 Edge 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 (main or tracking) 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 main/tracking protocol where the NAE is the main.
 - 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. Where a motor disconnect is indicated downstream of a variable frequency drive (VFD) provide interlock wiring from the auxiliary contacts on the disconnect to the VFD to de-energize when the disconnect is turned "off".

2.3. CONTROLLERS

- A. Temperature, relative humidity, and CO2 sensor covers shall be stainless steel wire guard type with vandal proof screws. All room relative humidity, CO2, and temperature sensors shall be mounted 4'-0 inches above the finished floor, except in 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. Provide individual sensors (combination sensors are not acceptable).
- B. Space sensor wiring shall be installed concealed where possible. Should the Division 23 Contractor be unable to do so then surface metal raceway shall be utilized as specified in Division 26.
- C. 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 all fans and close the outside air damper if air temperature drops below 35 degrees F and open hot water heating valves. Low limit thermostats shall include hardwire interlock to fans and the building automatic control system. Low limit thermostats shall remain active even when H-O-A switches are in "HAND". Additional requirements are indicated in Sequence of Operation.
- D. Room temperature sensors shall be accessible to ADA occupants.
- E. All global sensors shall be monitored in accessible locations. Exterior sensors shall be provided with sun shield and be installed to prevent bird nesting.

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 or modulating 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. 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 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. Duct Smoke Detectors

1. Duct 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. A venturi flow meter fitting shall be field installed so that the flow rate can be read by means of differential pressure. Valve shall include a factory or field installed 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. Provide separate flow meter fitting if venturi flow meter is not integral to PIC valve assembly.
 - 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.
 - 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 $\pm 5\%$ 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: $\frac{1}{2}$ "-40:1, $\frac{3}{4}$ "-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 $\pm 5\%$ (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 venturi flow meter fitting to measure flow rate in gallons per minute.
 - vii. Valve shall include a venturi flow meter fitting so that the flow rate can be read by means of differential pressure. Venturi flow meter fitting shall not require any straight runs of piping before or after meter. Provide separate flow meter fitting if not integral to control valve.
- 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. Where applicable, all two (2) position control valves may be furnished with hose kits at Contractor's option. Coordinate actuator and pressure drop requirements with hose kit supplier. Maximum allowable pressure drop for two (2) position modulating control valves shall be 12 feet at scheduled flow rate.
- 5. Optional accessories shall include a stem packing lubricator for factory or field assembly. Valve stem packing shall be low friction, tight sealing Teflon.
- 6. 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.
- 7. All valves shall use guided valve plugs for good seating and reliable operation. Valves ½ 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.

8. 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: 16GB.
 - 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. Two (2) Network Interface Cards: Include cards 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 Caesar Rodney School District's Central Maintenance Office shall be utilized with the new CCMS System. Provide modem terminal, and wiring as required to interface this school's CCMS system with FMS computer. I/P data drop shall be provided adjacent to the network panels.
- b. Coordinate IP address with Owners' I.T. Department for network connection. The CCMS must be fully networkable.
- c. Provide fiber optic cable as required.
- d. Extend Existing Building Management System (BMS) as required to accommodate all equipment on this project.

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, or 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
- 1) 4-20 mA
- 1) 0-5 VDC
- 1) 0-12 VDC

ii. 1000 ohm platinum (at 0°C, 2.62 ohms/°C)

iii. 1000 ohm Balco (2.2 ohms/°F)

iv. 10 k ohm Thermistor (at 25°C/77°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 Digital Controller (AHDC)

1. General

- a. Controls shall be microprocessor based, Air Handler Digital Controllers (AHDC's). AHDC's shall be provided for energy recovery ventilators, single zone VAV unit, 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 or 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, Johnson Controls Facility Explorer, 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 via e-mail.

- 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 temperature sensor shall employ a non-reactive organic bobbin material to give precise dew point temperature readings with accuracy of not more than + 1.5 degrees F. The dew point temperature 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 temperature 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 relative 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, dew point temperature, relative 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
 - a. 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.
 - b. 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.
 - c. 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.
 - d. 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. 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.

2.15. 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 per manufacturer's requirements.

2.16. 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.

2.17. 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, cafeteria, and corridors install heavy duty stainless steel guards.

2.18. CHILLER THERMAL DISPERSION FLOW SWITCHES

- A. Furnish and install thermal dispersion flow switches in chiller piping as indicated on the Contract Drawings. The thermal dispersion flow switches shall be manufactured by IFM Efector, Inc., or approved equal. Coordinate exact chiller thermal dispersion flow switch

requirements with the chiller manufacturer.

- B. Units shall be normally open type and shall be interlocked to prevent chiller from operating until the fluid flow is proven. Unit shall be fully adjustable and include function display LED. Units shall be constructed of 316L stainless steel including housing and material surface sensor. All wetted surfaces shall also be constructed of 316L stainless steel.
- C. Furnish with M12 connector and wiring for interface to chiller and automatic temperature control system. Coordinate wiring with ATC system and chiller control panel.
- D. Install assembly, sensor, and adaptors as required.

2.19. DEW POINT TEMPERATURE SENSORS

- A. Furnish and install dew point temperature sensors where indicated on the Contract Documents.
- B. Dew point temperature sensor shall be model DP4AS as manufactured by TelAire or approved equal. Unit shall monitor dew point temperature and dry bulb temperature and report the same on the ATC system.
- C. Units shall comply with the following:

Accuracy	
Enthalpy	± 2 BTU/lb
Dew Point Temperature	± 1.8°F (± 1°C)
Wet Bulb	± 3°F (± 1.7°C)
Dry Bulb	± 0.5°F (± 0.9°C)
Supply Voltage	18-30 VDCm 100 mA
Signal Output	Field selectable: 4-20 mA (700Ω max load), 0-5 V, or 0-10 V Humidity and dry bulb temperature
Measurement Range	
Dew Point: Space	40° to 90°F (4.4° to 32.2°C)
Enthalpy: Space	0-50 BTU/lb
Wet Bulb Space:	40° to 90°F (4.4° to 32.2°C)
Dry Bulb Space:	40° to 90°F (4.4° to 32.2°C)
Sensing Technology	Capacitive and replaceable
Operating Humidity	0 to 99% RH, non-condensing
Warranty	1 Year

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 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 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, relative 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, relative humidity sensors, CO2 sensors, and other exposed control sensors with plans and room details before installation. Align with lighting switches and relative humidity sensors, and dewpoint temperature sensors.
- 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 Relative 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, pumps, 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.
- D. In projects with condensing units/heat pumps, the evaporator fans shall be hard wired interlocked with the condensing unit/heat pumps so that if evaporator fan fails, the condensing unit/heat pump shall de-energize.
- E. All boiler primary pumps shall be hardwired interlocked with boilers so that if primary pump fails, boiler shall de-energize.
- F. All chiller primary pumps shall be hard wired interlocked with chiller so that if the primary pump fails, the chiller shall de-energize.

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, 50, 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 CO₂, temperature, and relative 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.

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DIVISION 23 SECTION 23 09 23
AIRFLOW MONITORING STATIONS
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SECTION 23 09 23 – AIRFLOW MONITORING 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. Section Includes:
 - 1. Airflow measurement stations and sensors.
 - 2. Airflow switches.
 - 3. Airflow transmitters.
- B. Related Requirements:
 - 1. Section 230900 "Instrumentation and Controls of HVAC and Plumbing Systems" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3. DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. FEP: Fluorinated ethylene propylene.
- C. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.
- D. PEEK: Polyetheretherketone.
- E. PTFE: Polytetrafluoroethylene.
- F. PPS: Polyphenylene sulfide.
- G. RS-485: A TIA standard for multipoint communications using two twisted pairs.
- H. RTD: Resistance temperature detector.
- I. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.4. ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation instructions, including factors affecting performance.
 - 5. Product certificates.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include diagrams for air and process signal tubing.
 - 5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.
- C. Delegated-Design Submittal:
 - 1. Schedule and design calculations for flow instruments, including the following.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure drop at Project design and minimum flow conditions.

1.5. INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each product requiring a certificate.
- B. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Documentation of NIST traceability.

1.6. CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.7. MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during two-year period following warranty period.

PART 2. PRODUCTS

2.1. PERFORMANCE REQUIREMENTS

- A. Delegated Design: Select and size products to achieve specified performance requirements.
- B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2. GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

- A. Air sensors and transmitters shall have an extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
- B. Source Limitations: For flow instruments, obtain products from single source from single manufacturer.

2.3. AIRFLOW MEASUREMENT

- A. General Requirements:
 - 1. Adjustable for changes in system operational parameters.
 - 2. Airflow Sensor and Transmitter Range: Extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions.
 - 3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
 - a. Product certificates are required.
 - 4. System Accuracy: The total system accuracy, including array averaging error, transducer error, etc... when installed in accordance with the manufacturer's recommendations and without field adjustment shall be as follows throughout the entire operating range.
 - a. Ducts and plenums: +/- 3% of reading

- b. Outside air intakes +/- 5% of reading
 - c. Fan inlets +/- 10% of reading
 - 5. Recalibration:
 - a. If the technology provided requires recalibration, the contractor shall be responsible for recalibrating the system on a semi-annual basis during the construction phase through the end of the project warranty period.
 - 6. Product Applications
 - a. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
 - i. The contractor will be required as part of the submittal process to provide a working demo that demonstrates that the unit will operate at the lowest air flows possible on the project. If the manufacture is unable to provide a working demo than their submittal will not be reviewed by the design team.
 - b. Duct-Mounted Airflow Sensors:
 - i. Measured Velocities 500 fpm and Less:
 - 1) Thermal dispersion airflow station.
 - ii. Measured Velocities Greater than 500 fpm:
 - 1) Thermal dispersion airflow station
- B. Duct Mounted Thermal Dispersion Airflow Measuring Station:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ebtron: Gold Series. (Basis of Design)
 - b. Air Monitor Corporation: Electra-Flo
 - 2. Source Limitations: Obtain airflow and temperature measuring sensors and transmitters from single manufacturer.
 - 3. Description: Airflow station shall consist of one or more sensor probes and a remotely mounted microprocessor-based transmitter.
 - 4. Performance:
 - a. Capable of independently processing up to 16 independently wired sensor assemblies.
 - b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
 - c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.
 - d. Listed and labeled by an NRTL as successfully tested as an assembly according to UL 873, "Temperature-Indicating and Regulating Equipment."
 - e. Components shall be interconnected by exposed NRTL-listed plenum-

- rated cable or non-listed cable placed in conduit.
 - f. Each flow station shall be factory calibrated at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.
 - g. Airflow Accuracy: Within 2 percent of reading over the entire operating airflow range, with 0.25 percent repeatability.
 - i. Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.
 - h. Temperature Accuracy: Within 0.15 deg F over entire operating range of minus 20 to plus 160 deg F.
 - i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F.
 - j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F.
 - k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.
 - l. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.
 - m. Pressure Drop: 0.05-inch wg at 2000 fpm across a 24-by-24-inch area.
 - n. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than 1 percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan in order to deliver Project design airflow indicated.
5. Sensor Assemblies:
- a. Each sensor probe shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
 - b. Mount thermistors in sensor using a marine-grade, waterproof epoxy.
 - c. Thermistor leads shall be protected and not exposed to the environment.
 - d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.
 - e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.
 - f. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 316 polished stainless steel.
 - g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.
6. Transmitter:
- a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
 - b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.

- i. Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
 - 1) Integral protection from transients and power surges.
 - 2) Circuitry to ensure reset after power disruption, transients, and brownouts.
 - 3) Integral transformer to convert field power source to operating voltage required by instrument.

2.4. AIRFLOW TRANSMITTERS

A. Airflow Transmitter with 0.10 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ebtron
 - b. Air Monitor Corporation: Veltron Mass-tron II
2. Transmitter shall receive total- and static-pressure signals from a primary element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
3. Transmitter shall have built in capability for both process temperature and pressure compensation.
4. NEMA 250, Type 1 enclosure.
5. Construct assembly so that shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
6. Transmitter shall include automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.
7. Performance:
 - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
 - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
 - c. Accuracy: Within 0.10 percent of natural span.
 - d. Repeatability: Within 0.15 percent of calibrated span.
 - e. Linearity: Within 0.2 percent of calibrated span.
 - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
8. Integral multi-line digital LED or digital display for continuous indication of airflow.

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. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
 - 1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
 - 2. Do not begin installation without submittal approval of mounting location.
- E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
- F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to force.
- D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- F. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
 - a. Laboratory exhaust airstreams.
 - b. Process exhaust airstreams.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3. ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Refer to Division 26.
- C. Furnish and install power wiring. Refer to Division 26.
- D. Furnish and install raceways. Refer to Division 26.

3.4. INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
 2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 3. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 4. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Mounting Height:
 1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply

with codes and accessibility requirements.

2. Unless indicated otherwise, mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches (1050 to 1800 mm) above the adjacent floor, grade, or service catwalk or platform.
 - a. Make every effort to mount at 60 inches (1500 mm).
3. Where indicated for rooftop equipment, mount display within rooftop equipment.
- C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5. FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Transmitters:

1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.

3.6. IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26.
- B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.7. CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.8. CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
 2. Check instruments for proper location and accessibility.
 3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
 4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- B. Flow Instrument Checkout:
1. Verify that sensors are installed correctly with respect to flow direction.
 2. Verify that sensor attachment is properly secured and sealed.
 3. Verify that processing tubing attachment is secure and isolation valves have been provided.
 4. Inspect instrument tag against approved submittal.
 5. Verify that recommended upstream and downstream distances have been maintained.

3.9. ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
 4. Equipment and procedures used for calibration shall meet instrument manufacturer's recommendations.
 5. Provide diagnostic and test equipment for calibration and adjustment.
 6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
 7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
 9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- B. Analog Signals:
1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- C. Digital Signals:
1. Check digital signals using a jumper wire.
 2. Check digital signals using an ohmmeter to test for contact.
- D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- E. Switches: Calibrate switches to make or break contact at set points indicated.
- F. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.10. DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

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DIVISION 23 SECTION 23 30 00
HVAC AIR DISTRIBUTION
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SECTION 23 30 00 - 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 air handling equipment, 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. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE/SMACNA Table of equivalent rectangular and round ducts.
- 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. All ductwork exposed to chemicals or shall be corrosion resistant and shall include a corrosion resistant 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. SMACNA - HVAC Air Duct Leakage Test Manual
- P. UL 181 - Factory-Made Air Ducts and Connectors.
- Q. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
- R. NFPA 70 - National Electrical Code
- S. SMACNA - HVAC Duct Construction Standards - Metal and Flexible
- T. UL 33 - Heat Responsive Links for Fire-Protection Service.
- U. UL 555 - Fire Dampers

1.3. 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.

1.4. REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA- 90A and NFPA-90B Standards.

1.5. 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.

1.6. 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, unistrut, kindorf or channel; strap hangers or the use of wire will not be permitted. All thread hangers shall not pass through or be inside duct. Hangers shall not penetrate the duct insulation vapor barrier. 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, excelon, or other NFPA approved non-inflammable fabric shall be provided in the duct system at all fan inlet and outlet connections. Flexible duct connectors shall be Durodyne or approved equal.
- 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.).

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. 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.
14. Determine duct gauges per SMACNA based on duct size and pressure indicated.

2.4. CONDENSING BOILER INTAKE DUCTWORK (PIPING) MATERIAL

- A. 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).
 5. Boiler intake ductwork shall be PVC.
- B. For Boiler Exhaust/Flue Ductwork refer to “Stacks and Breeching” in Part 2 of this specification section.

2.5. 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.

2.6. 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, Vent Products Company, 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. Provide blade stops to minimize air gaps around damper blades when closed.
- 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. Where volume dampers are installed in exposed finished spaces locate damper handle on top of duct.
- H. 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.
- I. Where existing air devices do not contain manual volume dampers in the run-out ductwork, install manual volume damper at each existing air device duct runout.

2.7. 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.

2.8. 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 energy recovery ventilators, single zone VAV units, and ducted fan coil units:

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.

2.9. 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, Vent Products Company, 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.

2.10. 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 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.

2.11. 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.

2.12. DUCT LINING (LOW PRESSURE DUCTWORK)

- A. All low pressure supply and return ductwork within 10 feet of fan coil units, energy recovery ventilation units, single zone VAV 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 ventilation 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.

2.13. 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 or equipment breeching, as hereinbefore specified, shall be provided for all new fuel-fired equipment, including but not limited to boilers.
- J. General Electric RTV106 (aka Mumentive) 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.

2.14. AIR DEVICE REQUIREMENTS

- A. Furnish and install air supply, return, exhaust devices of sizes and capacities as scheduled on the drawings. Catalog numbers shown are Titus, Inc., products for equipment which have been found suitable for the application. Other manufacturers listed below 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, open ended ducts, 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. 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.
- C. Contractor shall determine frame and mounting type as per type of ceiling as shown on Architectural drawings.
- D. Air devices and accessories that are installed in a finished, non-white ceiling shall be of a color as selected by the Architect.
- E. Noise Criteria: All air devices shall be sized and selected to limit maximum NC (Noise Criteria) levels to 30.

2.15. SUPPLY AIR DEVICES

- A. SD1 Diffuser, Square/Rectangular
 - 1. Manufacturers: Subject to compliance with requirements, provide products by

one of the following:

- a. Titus Model TDCA-AA
- b. Metal-Aire
- c. Price
- d. Tuttle & Bailey
- e. Anemostat
- f. Carnes
- g. Nailor
- h. Krueger

2. Construction:

- a. Material: Aluminum
- b. Finish: Baked Enamel, White Baked enamel, color selected by Architect
- c. Face Style: Louvered
- d. Mounting: Lay-in or Gypboard
- e. Pattern: Adjustable core style
- f. Damper: Integral, Opposed Blade type

3. Accessories:

- a. Square to round neck adaptor
- b. Adjustable pattern vanes

4. Provide auxiliary panel for lay-in tile installation.

5. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.16. RETURN/EXHAUST/TRANSFER GRILLES

A. RG1 Return/Exhaust/Transfer Grille, Square/Rectangular

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Titus Model 350FS
- b. Metal-Aire
- c. Price
- d. Tuttle & Bailey
- e. Anemostat
- f. Carnes
- g. Nailor
- h. Krueger

2. Construction:

- a. Material: Aluminum
- b. Finish: White Baked Enamel

- c. Ceiling Type: Lay-in, Gypboard, Sidewall
 - d. Blades: Fixed, 35° Angle, 3/4" Spacing
 - 3. Accessories:
 - a. Face: Grille
 - b. Damper: Integral, Opposed Blade type
 - 4. Provide auxiliary panel for lay-in tile installation.
 - 5. The register shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.
- B. RG2 Return/Exhaust/Transfer Grille, Square/Rectangular with Filter, Aluminum
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Titus Model 350FSF
 - b. Metal-Aire
 - c. Price
 - d. Tuttle & Bailey
 - e. Anemostat
 - f. Carnes
 - g. Nailor
 - h. Krueger
 - 2. Construction:
 - a. Material: Aluminum
 - b. Finish: White Baked Enamel
 - c. Ceiling Type: Lay-in, Gypboard, Sidewall
 - d. Blades: Fixed, 35° Angle, 3/4" Spacing
 - 3. Accessories:
 - a. Face: Grille
 - b. Damper: Integral, Opposed Blade type
 - 4. Provide auxiliary panel for lay-in tile installation.
 - 5. Provide return air filter racks and 1" thick filters.
 - 6. The register shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.
- C. RG3 Return/Exhaust/Transfer Grille, Square/Rectangular with Filter, Steel
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Titus Model 350RSF

- b. Metal-Aire
 - c. Price
 - d. Tuttle & Bailey
 - e. Anemostat
 - f. Carnes
 - g. Nailor
 - h. Krueger
 - 2. Construction:
 - a. Material: Steel, 16 gauge
 - b. Finish: White Baked Enamel
 - c. Ceiling Type: Sidewall
 - d. Blades: Fixed, 35° Angle, 3/4" Spacing
 - 3. Accessories:
 - a. Face: Grille
 - b. Damper: Integral, Opposed Blade type
 - c. Core: Hinged
 - 4. Provide return air filter racks and 1" thick filters.
 - 5. The register shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.
- 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, Vent Projects Company, 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.
 - 9.

2.19. INTAKE/RELIEF HOODS

- A. Furnish and install heavy gauge aluminum intake/relief hoods of size, capacity, and arrangement as shown on Contract Drawings. Intake/relief hoods shall be Greenheck Model FHI for intake or Model FHR for relief as manufactured by Greenheck, ACME Engineering, Cook, Twin City, Vent Products Company, or approved equal.
- B. Gravity roof ventilators shall be constructed of heavy gauge aluminum or galvanized steel. Hoods shall be constructed of precision formed, arched panels with interlocking seams. Bases shall be constructed so that the curb cap is 8 inches larger than the throat size. Insulated roof curbs shall be furnished as specified and shall be of same manufacturer as roof hood.
- C. Hood support members shall be constructed of galvanized steel and fastened so that the hood can be either removed completely from the base or hinged open. Birdscreens

constructed of ½ inch galvanized steel mesh shall be mounted horizontally across the intake/discharge area of the hood. Intake units with throat widths through 42 inches shall ship assembled when throat lengths do not exceed 84 inches. Relief units with throat widths through 48 inches shall ship assembled when throat lengths do not exceed 96 inches.

- D. Motor-operated dampers shall be provided by the ATC Subcontractor and installed by Mechanical Contractor.
- E. Provide 12-inch high, fully insulated, aluminum roof curbs with each hood. Hood and roof curb shall be provided by the same manufacturer.

2.20. 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.
- D. Behind all open end ducts, paint ductwork and dampers with two (2) coats of flat black paint.

2.21. 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".

2.22. 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.

2.23. AUXILIARY DRIP PANS

- A. Furnish and install suitable watertight, aluminum drip pans for all suspended single ducted fan coil units, single zone VAV units, energy recovery units and pumps 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 equipment. 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 for fan coil units, energy recovery units, and single zone VAV units. All control and interlock wiring to be furnished and installed under Division 23 Section, "Instrumentation & Controls of HVAC & Plumbing Systems"

2.24. 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. All duct supports in janitor's closet areas shall be provided with noncorrosive metal finish such as Galv-Krom or equal.
- 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. Also provide temporary closures of metal or taped polyethylene at all air handling equipment openings to prevent dust from entering equipment openings.
- Q. Paint behind all air devices, louvers, and open end ducts with 2 coats of flat black paint.

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. Also provide temporary closures of metal or taped polyethylene at all air handling equipment openings to prevent dust from entering equipment openings.
- 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. Provide for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 10 x 10 inch size for hand access, 18 x 18 inch size for shoulder access 20 x 20 inch for kitchen exhaust systems. 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. For all motor operated dampers, mark the shaft so operators know the position of the damper.
- E. 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.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. 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".
- H. 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.
- I. Use splitter dampers only where indicated.
- J. 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.
- K. Install diffusers, registers, and grilles to ductwork with airtight construction.
- L. Check location of all air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangements.

- M. 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.
- N. 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.
- O. Install duct accessories according to applicable details shown in SMACNA's HVAC Duct Construction Standards Metal and Flexible for metal ducts.
- P. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- Q. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- R. 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.
- S. Adjust duct accessories for proper settings.
- T. Adjust fire dampers 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. CONDENSING BOILER 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.
- O. For existing buildings, offset flues/combustion air ducts as required to clear existing structure.

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, motor operated dampers, duct access doors, duct detectors, and duct coils shall be installed prior to duct leakage testing.
- E. Submit a complete report of the ductwork leakage tests to the Engineer and include final approved copies in test and balance reports.

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/fan identification and area served.
- E. Length of fan color field for ductwork shall be 32 inches. Lettering shall be minimum 3-1/2 inches high.

END OF SECTION

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DIVISION 26 SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL
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SECTION 26 05 00 - 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 012300, *Alternates* for description of work under this Section affected by Alternates.

1.3 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Foam Duct Sealant.
 - 5. Grout.
 - 6. 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. 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 26 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.

1.4 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 010000, *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.

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 outlets, power wiring, etc.
- D. 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.
- 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 installed.
- 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 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.
- G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, or 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. 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.
- J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.
- K. 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. Existing items of

equipment are being 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. The Contractor shall only submit those manufacturers indicated in the Specification. 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. Alternate manufacturers will not be considered unless the specific item indicates "or as approved equal". 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 ELECTRICAL WORK UNDER OTHER DIVISIONS

- A. Mechanical Equipment and Systems
 - 1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.
 - 2. Certain mechanical units are furnished from the factory with starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, the Electrical Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Mechanical Contractor so that one and only one, set of starters, fuses, switches, etc., is provided and installed.
 - 3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Division 23. Division 26 shall install and connect all such equipment as necessary.
 - 4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided under Division 23. Division 26 shall install and connect all such equipment.

- B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Provide power circuits and disconnects to such equipment and install all electrical control equipment related thereto.
- C. Owner Furnished Equipment: In general, Owner furnished equipment is either provided or wired by the equipment supplier. Provide power circuits to such equipment and make final connections to equipment being provided by the Owner.
- D. Carefully review the Contract Documents and coordinate the electrical work under the various Divisions.

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. The application standards of the local electric utility company.
- 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.

1.11 SUBMITTALS

- A. Product Data: For items specified in Part 2 of this Section.

1.12 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/Engineer, to be in best interest of Owner.
- B. After acceptance of Material and Equipment List, submit six (6) copies, or more as required under the 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.

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. Submit Product 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.

Items and Systems

- 1. Basic Electrical Materials
- 2. Cable – 600 Volt
- 3. Circuit Breakers
- 4. Conduit and Surface Raceway
- 5. Contractor and Subcontractor Qualifications
- 6. Controllers and Control Devices
- 7. Equipment Connections
- 8. Firestopping
- 9. Ground Conductors, Rods
- 10. Identification System
- 11. Lighting Control Equipment
- 12. Light Fixtures
- 13. Low Voltage Fuses
- 14. Material and Equipment List
- 15. Motor Controllers
- 16. Occupancy and Vacancy Sensors
- 17. Outlet Boxes
- 18. Receptacles
- 19. Record and Information Booklet
- 20. Safety Switches
- 21. Schedule of Values
- 22. Sleeves, Hangers, Supports
- 23. Submittal Schedule

- 24. Tests and Reports
 - 25. Wiring Devices
 - 26. Wiring Diagrams
- D. 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.
- E. Submit for approval any other shop drawings as required by the Architect/Engineer. 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.
- F. Submit for approval schematic diagrams of each electrical system installed in the building. 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 framed, mounted under glass and hung in each Main Equipment Room. Deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
- 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. 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.

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, 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 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.

1.17 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared six (6) copies of the Operations 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: *Operations and Maintenance Manual – Magnolia Middle School - 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. 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 Electrical Certificates.

10. Start-up reports for equipment.
- D. Submit Operations and Maintenance Manual prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operations and Maintenance Manuals be reviewed and approved.
- E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.
- F. Deliver all instruction materials to the Owner prior to the formal instruction period.
- G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.
- H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.
- I. 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.
- J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.
- K. Where specified in technical sections, provide longer periods required for specialized equipment.
- L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.
- M. The Operations and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.
- N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

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 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Bridgeport Fittings, Inc.
 - c. Calpico, Inc.
 - d. GS Metals Corporation
 - e. Metraflex Co.
 - f. O-Z/Gedney
 - g. Pipeline Seal and Insulator, Inc.
 - h. Racor, Inc.
 2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 3. Pressure Plates: Stainless Steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 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).

2.5 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.

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 and lighting, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service will be determined by the General Contractor.
- 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. The Contractor shall pay for all energy charges for temporary service.

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 2008 NEC Article 110.26.
- 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 service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.
- 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. Right of Way: Give to piping systems installed at a required slope.
- J. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:
1. Countertops, Casework and Cabinets.
 - a. Do not install outlets, switches, etc., behind casework, cabinets, etc.
 - b. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
 - c. Coordinate counter top outlets with drilling of casework/counters.
 - d. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

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. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- 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
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements of Division 07 Section 079200 *Joint Sealants*.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 26 Section 260528 *Electrical Firestopping*.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Cut sleeves to length for mounting flush with both surfaces of walls.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.

- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 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*.

3.6 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.

3.7 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 OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.8 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, 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, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.9 COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.

3.10 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.

3.11 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 015000 *Temporary Facilities and Controls*.
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.12 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/Engineer for approval.

3.13 WALL AND FLOOR PENETRATIONS

- A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 26 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 26.
- 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. Where penetrating through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these Specifications.
- D. 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.
- E. 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.

3.14 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.

3.15 PHASING

- A. Refer to Architectural Specifications and Contract Drawings for any required phasing.
- B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities Having Jurisdiction (AHJ).
- C. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.
- D. The Building shall remain watertight at all times.
- E. Refer to phasing plans for additional requirements.

- F. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the Owner and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.
- G. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The Contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.16 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 the end of this Section, to Owner for approval.

3.17 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.
- B. Do not cut structural members without approval from the Architect or Engineer.

3.18 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, vent assemblies, 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.

3.19 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.

3.20 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, Article "Provisions for Access".
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section 260528 *Electrical Firestopping*.

3.21 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. Refer to phasing plans for additional requirements.
- E. Where any abandoned conduits in existing floors, walls, pipe tunnels, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.
- F. 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.
- G. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authorities Having Jurisdiction (AHJ).
- H. Make provisions and include in bid all costs associated with confined entry/space requirements in crawl spaces and all other applicable OSHA regulations.
- I. 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.
- J. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.
- K. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- L. 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.

- M. 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.
- N. 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.
- O. 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.
- P. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.
- Q. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.
- R. 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.
- S. 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.
- T. Work Abandoned in Place: Cut and remove conduit a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- U. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- V. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.22 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: (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 MOSHA 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.

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: _____

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DIVISION 26 SECTION 26 05 02
ELECTRICAL DEMOLITION FOR REMODELING
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SECTION 26 05 02 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1. GENERAL

1.1 RELATED DOCUMENTS

- 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. Electrical demolition shall be carried out per the Contract Documents.
- B. Provide all cutting and patching for electrical construction.
- C. Provide temporary service and provisions to maintain existing systems.

PART 2. PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3. EXECUTION

3.1 EXAMINATION

- A. The Contractor shall examine the site, determine all conditions and circumstances and gather all data and information required for the work. Field investigations include, but are not limited to, performing surveys, opening of equipment enclosures, and other work as required to maintain existing systems.
- B. The Contractor shall survey all new and existing wiring, circuitry, cabling, equipment and devices. Data gathering shall include, but not be limited to, equipment nameplate information, ratings, voltage, wiring configurations, conductor lengths, conductor routing, conductor sizes, equipment connections, and other information as required to maintain existing systems.
- C. The Contractor shall provide complete field investigations to determine existing and new conductor, cable, and conduit routing, points of connections, and tracing of existing systems.
- D. Verify that field measurements and circuiting arrangements are as shown on the Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on casual field observation. Report discrepancies to the Owner, Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with the Owner, Architect, and Engineer. Also, coordinate utility service outages with Utility Company.

3.3 CONNECTIONS AND ALTERATIONS TO EXISTING SYSTEMS

- A. Keep all existing electrical systems in operation during the progress of the work. Provide temporary electrical connections to systems of equipment, etc., where necessary to maintain continuous operation until the new systems and equipment are ready for operation.
- B. When existing electrical work is removed, remove all conduit, ducts, supports, etc. to a point below the finished floors or behind finished walls and cap. Such points shall be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material.
- C. When the work specified hereunder connects to any existing equipment, conduit, wiring, etc., perform all necessary alterations, cuttings, fittings, etc., of the existing work as may be necessary or required to make satisfactory connections between the new and existing work and leave the complete work in a finished and workmanlike condition.
- D. When the work specified under other divisions necessitates relocation of existing equipment, conduits, wiring, etc., perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike condition.
- E. Contractor shall be responsible for removing and replacing existing ceiling tile within the lay-in ceiling areas as required. Contractor shall provide all necessary cutting and fitting of bushed holes for cable passage through tiles. Any tiles damaged during the Contract shall be replaced with like kind at no cost to the Owner.
- F. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. In particular, all security and safety systems must be maintained in operation at all times as required by the Owner. This includes security and safety lighting.
- G. Existing Electrical Service: Disable system only to make switchovers and connections. Obtain permission from Owner, Architect/Engineer and other trades at the site at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- H. Trace all circuits and controls to be disconnected to ensure that vital services to other areas are not interrupted.

3.4 PROTECTION

- A. Provide protection for all existing and new cabling. Provide inner duct, conduit or other suitable means of protection to prevent damage to cables located in renovated areas.

- B. Damage to wiring, cabling or equipment shall be repaired by skilled mechanics for the trade involved at no additional contract amount.
- C. Fixtures, materials and equipment shall be protected at all times. The Contractor shall make good any damage caused either directly or indirectly by his workmen. Conduit openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water and chemical or other injury. At the completion of all work, the fixtures, materials and equipment shall be thoroughly cleaned and turned over in a condition satisfactory to the Owner.
- D. Damage: Where wiring, raceways, lighting fixtures, devices or equipment to remain is inadvertently damaged or disturbed, cut out and remove damaged section and provide new of equal or capacity or quality.

3.5 ELECTRICAL DEMOLITION

- A. Remove from the premises and dispose of all existing wiring, conduit, material, fixtures, devices, equipment, etc., not required for re-use or re-installation.
- B. Deliver on the premises where directed existing material and equipment which is removed and is desired by the Owner or is indicated to remain the property of the Owner.
- C. All other equipment and materials which are removed shall become the property of the Contractor and shall be removed by him from the premises.
- D. Where electrical equipment is removed, also remove all wiring back to source panelboard or switch or to last remaining device on the same circuit. All conduit, hangers, supports, etc., shall also be removed unless otherwise noted. Such conduit may remain to be reused for new work provided said conduit is of the proper size and type as that specified and in a condition acceptable to Engineer and Owner.
- E. Any conduit abandoned in concrete slabs, walls, or other inaccessible locations shall be left empty except for a nylon pull wire. Ends shall be capped with push plugs for future use.
- F. Where an existing system is indicated to be removed, the Contractor shall provide complete removal of entire system including all wiring, conduit, and connected/associated fixtures and devices. The system shall be removed in its entirety unless otherwise noted.

3.6 EXISTING CONDUIT WORK

- A. Remove all abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove conduit back to point of penetration/exposure.
- B. Remove concealed abandoned raceway to its source.
- C. Abandoned Work: buried electrical work abandoned in place, shall be cut out approximately 2 inches beyond the face of adjacent construction, capped and the adjacent surface patched to match the existing finish.

- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if raceway servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Ensure access to existing boxes and other installations which remain active and which require access. Modify installation or provide access panel as appropriate.
- F. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- G. Clean and repair existing raceway and boxes that remain or are to be reinstalled.
- H. Remove all abandoned wiring from exiting conduits and ductbanks. Abandoned wiring that cannot be removed shall be tagged at each end as "Abandoned".
- I. Contractor shall provide all cutting and patching required to connect to and extend existing conduits, wiring, circuits, etc.

3.7 EXISTING WIRING AND CABLING WORK

- A. Remove all abandoned and unused wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes. Remove abandoned and unused cabling and wiring back to the source.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes if wire and cable servicing them is abandoned and removed. Provide blank cover for abandoned boxes that are not removed.
- C. Ensure access to existing wiring connections which remain active and which require access. Modify installation or provide access panel as appropriate.
- D. Extend existing circuits using materials and methods compatible with existing electrical installations or as specified.
- E. Clean and repair existing wire and cable that remain or is to be reinstalled.
- F. Provide supports for all wiring and cabling to remain as required by NEC.
- G. Contractor shall provide field services for racing out of all existing circuits to be maintained. Contractor shall locate, trace and label, all existing circuits being re-used.

3.8 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work to meet all requirements of these specifications.
- B. If certain raceways and boxes are abandoned but not scheduled for removal, those items must be shown on the As-Built Drawings.
- C. Remove, relocate, and extend existing installations to accommodate new construction.

- D. Remove abandoned wiring to source of supply.
- E. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- H. Extend existing installations using materials and methods (compatible with existing electrical installations, or) as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.

3.9 CLEANING AND REPAIR

- A. The Consultant shall show, on the drawings, all items to be cleaned or repaired.
- B. Clean and repair existing equipment and materials that remain or are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement. Trace existing circuits to determine exact location and type of load served by each circuit breaker.
- D. Provide new labels on all existing electrical equipment being re-used.

3.10 INSTALLATION

- A. Install relocated materials and equipment under the provisions of other sections.

END OF SECTION

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DIVISION 26 SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Procedures: Perform each visual and mechanical inspection and electrical test state din NETA ATS Section 7.3.1. Certify compliance with test parameters.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each new branch circuit conductor.
- E. Tests: New Service Entrance Cables, Power & Lighting Distribution Feeders and Feeders to all major mechanical equipment at 60A and over (i.e., chillers, AHU's, etc.).
 - 1. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
 - 2. Conductors shall be tested phase-to-phase and phase-to-ground.
 - 3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.

4. Test readings shall be recorded and delivered to Owner and Engineer in a report.
 5. Copy of Test results shall be included in O&M Manuals.
- F. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Wires and Cables:
 - a. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - b. BICC Brand-Rex Company.
 - c. Carol Cable Co., Inc.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
 - f. Encore Wire.
 - g. CommScope.
 - h. nVent PYROTENAX
 2. Connectors and Accessories for Wires and Cables:
 - a. AMP Incorporated.
 - b. Buchanan.
 - c. General Signal; O-Z/Gedney Unit.
 - d. Monogram Company; AFAC.
 - e. NSI Industries, Inc.
 - f. Square D Company; Anderson.
 - g. 3M Company; Electrical Products Division.
- B. Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN/THWN-2, XHHW, USE, and SO.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal clad cable, Type MC and Type SO with ground wire.

2.2 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. RoHS compliant.
 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8. for stranded conductors.
- D. Conductor Insulation:
1. Type RHH and Type RHW-2: Comply with UL 44.
 2. Type THHN and Type THWN-2: Comply with UL 83.
 3. Type XHHW-2: Comply with UL 44.
 4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
- E. Shield:
1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, and sunlight- and oil-resistant outer PVC jacket.

2.3 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Comply with UL 1569.
 3. RoHS compliant.
 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
1. Single circuit and multicircuit with color-coded conductors.
 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

- E. Ground Conductor: Insulated.
- F. Conductor Insulation:
 - 1. Type THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- G. Armor: Steel, interlocked.

2.4 FIRE-ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.5 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 "Wire and Insulation Applications" Article.
- 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: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- E. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.

- F. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- G. 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.
- H. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90°C and shall be material flame-retarded per IEEE 383 “Vertical Tray Flame Test”. 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. Wire nuts install in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.
 - 2. Connectors shall be UL listed appropriately sized according to manufacturer’s recommendation for the suitable wire sizes and voltage rating (600 volt minimum).
 - 3. Connectors body shall have a color-coded outer shell.
 - 4. Connectors shall be as manufactured by King Technology or approved equal.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Soft Drawn Copper, 98% conductivity minimum, solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Soft Drawn Copper. 98% Conductivity minimum, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. 600 volt, unless otherwise noted, #12 AWG minimum (except control cable may be #14 AWG).
- B. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- C. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC, except branch circuits concealed in CMU wall shall be EMT.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.
- J. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.
- K. Class 2 Control Circuits: Type THHN/THWN-2, in raceway.
- L. Conductors shall be rated 75 deg C in wet locations and 90 deg C in dry locations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 260429, "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553, "Identification for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

- a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
- 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
- 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- 5. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- D. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- E. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- F. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches (200 mm) of slack.
- D. Comply with requirements in Section 284621 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

- E. Wiring for general 15 and 20 amp 120 volt and 277 volt 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'	#12	0 – 175'	#12	0 – 100'	#12	0 – 200'	#12
60 – 100'	#10	175 – 350'	#10	100' & Up	#10	200' & Up	#10
100' & Up	#8	350' & Up	#8				

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, it is the Contractor's responsibility to ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

- F. 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.
- G. Joints of #8 AWG and larger in power and lighting circuits 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 "St-Kon", or equivalent. Connectors for control wiring shall be Burndy "Hy-Lug", or equivalent.
- H. All circuits for exterior electric work shall be #10 AWG (minimum) and contain an extra #10 AWG (minimum) copper ground conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted as larger on the Drawings.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Firestopping" and "Common Work Results for Electrical".
- B. Install to seal underground exterior-wall penetrations according to Division 26 Section, "Common Work Results for Electrical".

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test new service entrance and feeder conductors.
 - a. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
 - b. Conductors shall be tested phase-to-phase and phase-to-ground.
 - c. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.
 - d. Test readings shall be recorded and delivered to Owner and Engineer in a report.
 - e. Copy of Test results shall be included in O&M Manuals.
2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor.
- E. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

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ELECTRIC HEATING CABLES
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SECTION 26 05 20 - ELECTRIC HEATING 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 heating cables for the following applications:
 - 1. Heat tracing for freeze protection.

1.3. DEFINITIONS

- A. AWG: American Wire Gauge.
- B. C: Celsius.
- C. F: Fahrenheit.

1.4. SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer installed and field installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For electric heating cables to include in maintenance manuals specified in Division 01.
- E. Warranties: Special warranties specified in this Section.

1.5. QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,

Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6. COORDINATION

- A. Coordinate layout and installation of electric heating cables and system components with other construction.
 - 1. Coordinate with Food Service Equipment installer for piping installed under Division 11.
 - 2. Coordinate with piping installer, for condensate piping provided under Division 23.

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, executed by manufacturer agreeing to repair or replace components of electric heating cables that fail in materials or workmanship within specified warranty period.
- C. Warranty Period: Two years from date of Substantial Completion.

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. Accutron Heat Tracing Systems.
 - 2. Ari Industries.
 - 3. BICC Pyrotenax USA Inc.
 - 4. Caloric, Inc.
 - 5. Chromalox; Wiegard Industrial Division; Emerson Electric Company.
 - 6. Copperheat Inc.
 - 7. Delta Therm Corp.
 - 8. Easy Heat, Inc.
 - 9. INDEECO.

10. Maxxon Corp.; Infloor Heating Systems Div.
11. Nelson Heat Tracing Systems.
12. Omega Engineering Inc.
13. Raychem Corporation.
14. Thermon Manufacturing Co.

2.2. ELECTRICAL HEAT TRACING FOR PIPELINES

- A. The self-regulating heater shall consist of two (2) 16 AWG nickel coated-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.
- B. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation.
- C. The heater shall operate on line voltages of 120 volts without the use of transformers.
- D. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50 degrees F.

Pipe Size	Watts per foot
3 inch or less	5 watt
4 inch	5 watt
6 inch	8 watt
8 inch	2 strips - 5 watt
12 inch to 14 inch	2 strips - 8 watt

- E. Power connection, end seal, splice and tee kit components shall be applied in the field.

- F. The system shall be controlled by a thermostat set at 40 degrees F either directly or through an appropriate contactor.

2.3. ACCESSORIES

- A. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

2.4. PIPING FREEZE PROTECTION CONTROLS

- A. Heat trace cables providing freeze protection for piping shall be controlled by an electronic controller that is UL Listed for protection of piping against freezing.
- B. Electric heat trace controllers shall control, monitor, and communicate alarms and data for one heating cable circuit.
- C. Electronic heat trace controllers shall have the following features:
 - 1. Modbus RTU/RS-485, Modbus TCP/Ethernet, or BACnet/Ethernet communication module.
 - 2. Six character alphanumeric display.
 - 3. -40 degrees Fahrenheit to 140 degrees Fahrenheit (-40 degrees Celsius to 60 degrees Celsius) operation.
 - 4. Single or dual temperature sensor inputs to allow selection of one or eight control modes and programming of all temperature parameters.
 - 5. High and low temperature alarms.
 - 6. High temperature cut-out.
 - 7. Low current alarms.
 - 8. 30A rated electromechanical relay (EMR) output switch with device failure alarm.
 - 9. Ground fault alarm and trip.
 - 10. Proportional ambient sensing control to maximize energy efficiency.
 - 11. Minimum/Maximum temperature tracking
 - 12. Auto-cycling to momentarily energize the circuit during periods of non-use to detect issues with the heat tracing circuit.
- D. Provide Raychem Digitrace C910-485 heat trace controller, or approved equal by listed manufacturer.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Examine surfaces and substrates to receive heating cables for compliance with requirements for installation, tolerances, and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Ensure pipe testing is complete.
 - 3. Ensure surfaces and substrates are level and plumb.
- B. Test cables for electrical continuity before installing.
- C. Test cables for insulation resistance before installing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Cut cable(s) to lengths required.
- B. Install heater to cold lead connections in accessible locations. Do not embed in concrete or plaster.
- C. Avoid crossing expansion, construction, or control joints with heating cables. Provide sufficient slack conductor in expansion loop.
- D. Provide labels for piping insulation/jacketing to identify the same as “electrically heat-traced”.

3.3. CONNECTIONS

- A. Electrical installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of wiring, conduit, and specialties.
- B. Connect heating cables and other components to wiring systems.
- C. 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.
- D. Connect heat trace controllers for freeze protection to building management systems as required to transmit the following alarm conditions:
 - a. Low pipe temperature.
 - b. High pipe temperature.

- c. Loss of power.
 - d. Ground fault trip.
- E. Coordinate system integration with BMS Contractor.

3.4. FIELD QUALITY CONTROL

- A. Testing: Perform tests after installation but before application of coverings, such as insulation, plaster, or concrete.
 - 1. Test cables for electrical continuity before energizing.
 - 2. Test cables for insulation resistance before energizing. Remove cables if measured resistance is less than 10 megohms to ground.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation.
- C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5. ADJUSTING

- A. Set field adjustable thermostat ranges as indicated.

3.6. PROTECTION

- A. Protect installed heating cables, including leads, from damage prior to Substantial Completion.

END OF SECTION

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GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter, unless otherwise noted.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor, unless otherwise noted.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.
- I. Straps: Solid copper, copper lugs. Rated for 600 A.
- J. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits of the same type as the circuit conductors. Install in same conduit with circuit conductors.

- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Where ground lug and bonding conductors installed indoors exceed 3 feet in length, install in EMT conduit.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 2. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure 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.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

DIVISION 26 SECTION 26 05 28
ELECTRICAL FIRESTOPPING
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SECTION 26 05 28 - ELECTRICAL FIRESTOPPING

PART 1. GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Through-penetration firestopping in fire rated construction.
 - 2. Through-penetration smoke-stopping in smoke partitions.
- B. Related items: Raceway seals and manufactured electrical devices: Refer to Section 26 05 01.

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: 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, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption.
2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound or vibration absorption.

1.5 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.
- 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: Statement of qualifications.
- E. Applicators' qualifications statement: List past projects indicating required experience.

1.6 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).

1.7 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 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.

1.9 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. 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. All trades shall use products from the same manufacturer unless otherwise noted.

2.3 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 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.

2.4 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 1/2-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 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 conduits, cable tray, or other items, close unused portions of opening with firestopping materials tested for the application. See UL Fire Resistance Directory of Paragraph 2.2 of this document.
- E. Install smoke stopping as specified for firestopping.
- F. Provide sleeves the full thickness of the assembly being penetrated and cut sleeves to a length of 1-inch more than the over-all thickness of the penetration, or as recommended by the firestop manufacturer.
- G. All holes and voids shall be sealed the same day they are made.

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*

SEE NEXT PAGE.

PENETRA TING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/ CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1"& 2" 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+ 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 MPS-2+ WL1082 2000+	FC1002 CP 25 FC1003 2000, 2000+, 20003 FC1006 CP 25WB+
Non- Metallic	CAJ2001 FS-195+, 1"& 2" WIDE, PPD'S CAJ2002 FS-195+	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+	FC2002 FS-195+, PPD'S FC2007 FS-195+,

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	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" WIDE	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" WIDE	PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195+ FC2026 FS-195+ FC2028 FS-195+, 1' & 2" 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+	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+, 2003 FC3007 CP 25WB+, MPS-2+ FC3008 FS-195+

PENETRA TING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/ CEILING
	CBJ3016 CS-195+, FS-195+ CBJ3017 CS-195+, MPS-2+ FA3001 CP 25WB+ FB3004 CS-195+, MP WJ3015 2001 WJ3016 2001		
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.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
- B. Related Sections include the following:
 - 1. Metal Fabrications – For requirements for miscellaneous metal items involved in supports and fastenings.
 - 2. Joint Sealants – For requirements for firestopping at sleeves through walls and floors that are fire barriers.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide slotted metal angle and U-channel systems by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Alstrut.
 - c. Unistrut; Diversified Products
 - d. Power-Strut.
 - 2. Manufacturers: Subject to compliance with requirements, provide conduit sealing bushings and accessories by one of the following:
 - a. Bridgeport Fittings
 - b. GS Metals, Corporation
 - c. O-Z / Gedney
 - d. Raco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. 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) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
- C. Submit structural calculations for load and strength of each component and detailing of each assembly.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1, NECA 101 and NECA 105 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- E. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Comply with requirements in Section 099113 "Exterior Painting," Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
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SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
- C. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
1. AFC Cable Systems, Inc.
 2. Alflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
 10. Steel City.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT: ANSI C80.3.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: Steel compression type.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 BOXES, ENCLOSURES, AND CABINETS

- 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Erickson Electrical Equipment Company.
 4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet Division.
 10. Spring City Electrical Manufacturing Company.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), except shallow boxes shall be permitted to accommodate framing.
- L. Gangable boxes are allowed.

- M. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- N. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.4 WIREWAYS AND AUXILIARY GUTTERS

A. Metal Wireways and Auxiliary Gutters:

- 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:
 - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. EGS/Appleton Electric.
 - c. Erickson Electrical Equipment Company.
 - d. Hoffman.
 - e. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - f. O-Z/Gedney; a unit of General Signal.
 - g. RACO; a Hubbell Company.
 - h. Robroy Industries, Inc.; Enclosure Division.
 - i. Scott Fetzer Co.; Adalet Division.
 - j. Spring City Electrical Manufacturing Company.
 - k. Thomas & Betts Corporation.
 - l. Walker Systems, Inc.; Wiremold Company (The).
 - m. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 870 and UL Category Control Number ZOYX.
 - 2) Fittings and Accessories: Include covers, 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.
 - 3) Finish: Manufacturer's standard enamel finish.

- c. Options:
 - 1) Degree of Protection: Type 12 unless otherwise indicated.
 - 2) Wireway Covers: Screw-cover type unless otherwise indicated.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers Finish with manufacturer's standard prime coating. Provide size and all components, fittings, etc. required for a complete installation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wiremold / Legrand
 - b. Mono-Systems, Inc.
 - c. Panduit Corp.
 - d. Hubbell.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise noted.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
 - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

- a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT, support 6' on center maximum for sizes over 2-inches.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ Gedny Type B.
 3. Exterior rigid steel conduit box connections shall be made with a Meyers Hub fitting only. Meyers Hub fittings shall be Cooper Crouse-Hind type.
 4. All LB's, C, and T condulets shall be constructed of malleable iron. No aluminum/die pot metal type permitted.
 5. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 6. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only in finished spaces where concealment of conduit in existing walls is not feasible.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit within CMU walls, finished walls, ceilings, and floors, unless otherwise indicated. Conduits to surface mounted panelboards in electrical equipment rooms may be installed exposed.
- H. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene 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 pull wire.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Conduit extending from interior to exterior of building.
 - 4. Conduit extending into pressurized duct and equipment.
 - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

6. Where otherwise required by NFPA 70.
- M. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- N. Expansion-Deflection Fittings: 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 sleeve, 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.
1. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:
 - a. Axial expansion or contraction up to 3/4-inch.
 - b. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
 - c. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.
 2. Expansion/Deflection fitting shall be OZ/Gedney Type DX or approved equal by Crouse Hinds (Type XD).
- O. Bushings:
1. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type – 150 deg C temperature rating.
 2. Bushings for 1-1/4-inch conduit and larger shall be malleable iron body with 150 deg C insulating ring. Insulating material shall be locked in place and non-removable. Provide O-Z/Gedney Type B.
- P. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Q. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

- S. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- T. Locate boxes so that cover or plate will not span different building finishes.
- U. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- W. Set metal floor boxes level and flush with finished floor surface.
- X. Raceways Penetrating Rooms or Walls with Acoustical Requirements:
 - 1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
- Y. Exposed conduits in finished spaces where there is no ceiling, and where ceiling is perforated, shall be painted, color as selected by architect.

3.3 INSTALLATION OF SURFACE RACEWAYS

- A. Surface metal raceway shall only be utilized where devices and/or wiring cannot be concealed in existing walls in finished areas, such as classrooms, offices, corridors, toilets, etc. unless otherwise indicated on the Contract Documents.
 - 1. New devices installed in existing metal stud/GWB walls shall be cut in with conduit/wiring concealed within the wall.
 - 2. New devices installed in existing CMU walls may be installed in surface-mounted outlet boxes served by surface metal raceway as specified in this Section.
- B. Exposed raceways shall be run in corners, beneath chalk and tackboard frames, adjacent to door trims, and in other ways to be as inconspicuous as possible, even when requiring additional lengths.
- C. Horizontal runs of raceways shall be kept to an absolute minimum. Exposed raceway shall be run vertically into ceiling spaces above and below.
- D. All exposed raceways shall be installed in a manner approved by the Architect/Engineer.
- E. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
- F. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- G. Two-hole straps are required.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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DIVISION 26 SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS
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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field for normal feeders, black letters on a yellow field for emergency feeders.
 - 2. Legend: Indicate voltage and system or service type.
- C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field for normal circuits, black letters on a yellow field for emergency circuits.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape: Permanent, bright-colored, continuous-printed polyethylene tape.
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 4. Embedded continuous metallic strip or core.
- B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- C. Metal-Backed, Butyrate Warning Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- D. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background for equipment connected to normal

power source, white letters on a red background for equipment connected to an emergency power source. Minimum letter height shall be 3/8 inch (10 mm).

- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).
- C. Comply with NFPA 70E and Section 260573 "Coordination Study" requirements for arc-flash warning labels.

2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 - 5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. In finished spaces, nameplates for panelboards shall be secured to the interior behind the door.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels with stainless screws.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 8 inches (200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20 A: Identify with snap-around label applied in bands. Install labels at 10-foot (3-m) maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring

system legend and system voltage. System legends shall be as follows:

1. Power - Orange.
 2. Fire Alarm System – Red.
 3. Security System – Blue and Yellow.
 4. Mechanical and Electrical Supervisory System – Green and Blue.
 5. Telecommunication Systems - Green and Yellow.
 6. Control Wiring – Green and Red.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground: Green.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - 5) Ground: Green.
 - d. All control wiring shall be color-coded when using wires of different color from the type used to designate phase wires.
 - e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs and metal-backed, butyrate warning signs.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. For electrical equipment such as disconnect switches, motor starters,

contactors, relays, pushbutton stations, etc., the label shall have the same designation as the equipment it serves. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated phenolic nameplates. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated phenolic nameplate, "Panel (designation)", "Served from (designation)".
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchboards.
- e. Transformers.
- f. Enclosed switches.
- g. Enclosed circuit breakers.
- h. Enclosed controllers.
- i. Variable-speed controllers.
- j. Push-button stations.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.
- m. Monitoring and control equipment.

END OF SECTION

DIVISION 26 SECTION 26 05 73
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY,
& ARC FLASH HAZARD ANALYSIS
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**SECTION 26 05 73 - SHORT CIRCUIT ANALYSIS, COORDINATION STUDY,
& ARC FLASH HAZARD 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. This Section includes computer-based, fault-current study. Electrical equipment shop drawings will not be reviewed/approved until the overcurrent protective device coordination study has been submitted.
- 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*. Arc-Flash Hazard Labels shall be provided for all electrical distribution equipment with level as determined by Study.
- C. The scope of the fault current study shall be for the entire electrical distribution system, including new and existing equipment. The scope of the arc flash hazard study shall be new equipment only.

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. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
 - 4. Arc Fault Hazards Evaluation.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Engineering Analysis and Coordination Study performed by Coordinated Power Engineering, Inc., or a comparable product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.

- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system, determined from the utility source. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchboard bus.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard.
 - 4. Loadcenter.
- B. Study electrical distribution system from normal power sources throughout electrical distribution system for Project.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, and IEEE 242.
 - 1. Transformers:
 - a. IEEE C57.12.00.
 - b. IEEE C57.96.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. New device(s) shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC-FLASH HAZARD

- A. Perform Arc-Flash Hazard Analysis for each piece of distribution equipment and provide results indicating personnel protective equipment required for the potential hazard. Provide arc flash hazard labels as required by the NEC on each piece of equipment indicating the calculated arc-flash hazard.

3.6 ARC FLASH LABELS

- A. Contractor shall provide a 4.0 in. x 4.0 in. 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. System Voltage
 - 2. Flash Protection boundary
 - 3. Personal Protective Equipment category
 - 4. Arc Flash Incident energy value (cal/cm²)
 - 5. Limited, restricted, and prohibited Approach Boundaries
 - 6. Study report number and issue date
- 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 of 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.

3.7 AVAILABLE FAULT CURRENT LABELING

- A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. 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

- C. Labels shall be printed by a thermal transfer type printer.
- D. Labels shall be field-installed by the Contractor.

END OF SECTION

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DIVISION 26 SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS
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END OF SECTION 4

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SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

- A. This Section includes requirements for commissioning the electrical 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. Lighting Control System(s)
 - a. Network control system

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 electrical systems, electrical, communications, 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.

1.4. CONTRACTOR'S RESPONSIBILITIES

- A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Electrical Contractor:
 - 1. Provide certified and calibrated 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.
- C. 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 electrical 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 electrical and emergency generator 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.
- 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1. TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that electrical 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 electrical 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. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
4. 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).
5. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
6. 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.
7. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.
8. Annotate checklist or data sheet when a deficiency is observed.
9. 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.

3.2. 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.

- C. Scope of Electrical Contractor Testing:
1. Testing scope shall include entire electrical installation, from incoming service through distribution systems to each space. It shall include measuring voltages and currents 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.
- D. Detailed Testing Procedures: CxA, with Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems, and equipment.
- E. Electrical System Testing: Electrical Contractor shall prepare a testing plan to verify performance of systems identified in Part 1 of this section. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of wiring to be tested, identified by identification marker. Markers shall be keyed to Drawings for each wiring sector showing the physical location of each item of equipment and electrical wiring test section. Drawings shall be formatted to allow each item of equipment and section of wiring to be physically located and identified when referred to in the system testing plan.
 2. Tracking checklist for managing and ensuring that all wiring systems have been tested.
- F. Deferred Testing:
1. If tests cannot be completed because of a deficiency outside the scope of the electrical 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.
- G. 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 electrical systems to verify proper operation of the electrical systems, the system it serves, the service it provides, and its location. 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

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LIGHTING CONTROL DEVICES
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SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide lighting controls that can operate as standalone local room network(s) and have the capability to expand to a central building wide network. The building wide network shall provide control, monitoring, adjustment and scheduling functionality. The system shall be PC based with software and historical data storage. The system shall support third party integration with the building management system through BACnet/IP.
- B. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Daylight-harvesting controls.
 - 4. Indoor occupancy/vacancy sensors.
 - 5. Low voltage switches.
 - 6. Contactors.
- C. Related Sections include the following:
 - 1. Division 26 Section 262726, *Wiring Devices* for snap switches.
 - 2. Section 260943 "Network Lighting Controls".

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coverage Plans: Provide full scale plans showing locations and coverage patterns for all occupancy/vacancy sensors.
- C. Location Plans: Provide full scale plans showing locations and coverage patterns for all devices.

- D. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Include riser diagrams showing all devices and wiring.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 SUBSTITUTIONS

- A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent and are not required to have all the parts and pieces listed.
- B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within 10 days prior to bid.
- C. Acceptable Manufacturers
 - 1. Basis of Design
 - a. Acuity Brand Controls; nLight.
 - 2. Alternative Manufacturers
 - a. Wattstopper; Digital Lighting Management
 - b. Hubbell NX
 - c. Eaton; Room Controller System

1.7 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide a wired digital networked lighting control system as indicated on the drawings. The system shall include, but not be limited to, occupancy/vacancy sensor(s), photo sensor(s), digital room controller(s), digital switches, and all interconnecting wiring required for a complete operational system. The Basis-of-Design System is the Acuity Brand Controls; nLight.

2.2 TIME SWITCHES

- A. Basis-of-Design product: Subject to compliance with requirements, provide Acuity or a comparable product by one of the following:
 - 1. Wattstopper.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Pass & Seymour.
 - 4. Cooper Industries, Inc.
 - 5. Intermatic, Inc.
- B. Digital Time Switches: Wall switch style, electroluminescent back-lit LCD display shows timer countdown, time-out adjustments from 5 minutes to 12 hours, compatible with electronic ballasts; UL listed, five-year warranty.

2.3 CONTACTORS

- A. Basis of Design Product: Subject to compliance with requirements, provide ASCO; 918 series with solid-state control module for 2 wire control with number of poles and ratings as indicated on the drawing, or a comparable product by one of the following:
 - 1. Square D; Schneider Electric.
 - 2. Allen-Bradley/Rockwell Automation.
- B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 1. Monitoring: On-off status.
 2. Control: On-off operation.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCm ADCX RJB or comparable product by one of the following:
 1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with a hand held digital configuration tool or a PC with appropriate software.
 - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
 - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
- C. Ceiling-Mounted Dimming Controls: Solid-state, digital light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye in order to automatically dim a lighting zone.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 104 deg F (0 to 40 deg C).
 3. Sensor Output: Digitally communicates with room controller to dim loads based on lighting conditions. Sensor is powered from the room controller.

- E. Light-Level Sensor Set-Point Adjustment Range: 10 to 200 fc (108 to 2152 lux)
- F. Provide unit suitable for Low Temp/High Humidity environments in SHOPS and other unconditioned spaces.
- G. Provide single or dual zone control capability, as applicable.

2.5 INDOOR OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCM PDT RJB, nWV PDT, or comparable product by one of the following:
 - 1. Wattstopper DLM
 - 2. Hubbell NX
 - 3. Eaton
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state digital indoor occupancy/vacancy sensors with a separate controller unit.
 - 1. Systems programming is done with a hand held digital configuration tool or a PC with appropriate software.
 - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
 - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
 - 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. Operation:
 - a. Occupancy Sensor: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
 - b. Vacancy Sensor: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
 - c. Time Delay for turning lights off adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.
 - 4. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the room controller.
 - 5. Mounting:
 - a. Sensor: Suitable for mounting, ceiling mounting and corner mounting.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Standard Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage Large Room): Detect occupancy anywhere in a circular area of 2000 sq.ft. (186 sq.m) when mounted on a 96-inch-(2440-mm) high ceiling.
- D. Ultrasonic/Microphonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Corridor): Detect occupancy anywhere within 48 feet (18.0 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 12 feet (3.7 m).
 4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (corner mount): Detect occupancy anywhere within a 30 foot (9145 mm) radius when corner mounted at ceiling or on wall at 120-inches

(3058 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

6. Detection Coverage (high bay): Detect occupancy anywhere within a 20 foot (6096 mm) radius when mounted at ceiling at 180-inches (4572 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

2.6 SWITCHBOX-MOUNTED LOW VOLTAGE OCCUPANCY/VACANCY SENSORS

- A. Subject to compliance with requirements, provide Sensor Switch nWSX-PDT-LV or nWSX-PDT-LV-DX (On/Off or Dimming to match function indicated on the drawings) or comparable product by one of the following:
 1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. General Description: Wall-mounting, solid-state units suitable for mounting in a single-gang switchbox.
 1. Operation:
 - a. Occupancy Sensor Mode: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
 - b. Vacancy Sensor Mode: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
 - c. Time Delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
 3. Mounting:
 - a. Sensor: Suitable for mounting in a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed.
 4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 5. Bypass Switch: Override the on function in case of sensor failure.
- C. Dual-Technology Type: Wall mounting; detect occupancy by using a combination of PIR and ultrasonic or microphonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
 1. Sensitivity Adjustment: separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12-inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12-inches/s (305 mm/s).
3. Detection Coverage: (Standard Room): Detect occupancy anywhere within a 15 foot radius (4572 mm) when wall mounted at 48-inches (1220 mm) above finished floor.

2.7 LOW VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight PODM, or comparable product by one of the following:
 1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. General Description: Low-voltage, momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 button configuration with the following features.
 1. Two-way infrared (IR) transceiver for use with personal, and configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- C. Two RJ-45 ports for connection to local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required to achieve multi-way switching.
- E. The following switch attributes may be changed or selected using a wireless configuration tool:

1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
2. Individual button function may be configured to Toggle, On only, or Off only.
3. Individual scenes may be locked to prevent unauthorized change.
4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
5. Ramp rate may be adjusted for each dimmer switch.
6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.8 DIGITAL ROOM CONTROLLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nPP16 or comparable product by one of the following:
 1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. Description: Self configuring, digitally addressable one, two or three relay controllers with 0-10 volt control for drivers and single relay application-specific plug load controllers (if applicable) Room controllers shall be provided to match room lighting load and control requirements and have the following features:
 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission.
 - b. Device has power.
 - c. Status for each load.
 - d. Configuration status.
 4. Quick installation features including:
 - a. Standard junction box mounting.
 - b. Quick low voltage connections using standard RJ-45 patch
 5. Plenum rated.

6. Manual override and LED indication for each load.
 7. Dual voltage (120/277 VAC, 60 Hz)
 8. Zero cross circuitry for each load.
 9. Controllers shall be equipped for fail-safe operation and shall be evaluated for this purpose.
 10. Controllers shall be activated by activation of the building fire alarm system.
 11. Controllers shall be equipped for activation by the building security system.
- C. On/Off/Dimming enhanced room controllers shall include:
1. Real time current monitoring.
 2. One, two or three relay configuration.
 3. Efficient 250 mA switching power supply.
 4. Four RJ-45 local network ports.
 5. One 0-10 volt analog output per relay for control of compatible LED drivers.
 6. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).
 7. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%.
 - b. Set high and low trim for each load.
 - c. Set lamp burn in time for each load up to 100 hours.
 8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only.
 - b. Automatic-ON/OFF configuration.

2.9 CONFIGURATION TOOL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight, or comparable products by one of the following:
1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton

- B. A configuration tool facilitates customization of local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Features and functionality of the wireless configuration tool shall include:
1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
 4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
 6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section, Low-Voltage Electrical Power Conductors and Cables.
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*.
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*."

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Owner's representative, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:

1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 2. Review the specifications for low voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 4. Discuss requirements for integration with other trades.
- C. Inspect and make notes to job conditions prior to installation:
1. Record minutes of the conference and provide copies to all parties present.
 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Owner's representative.

3.2 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*. Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section 260553, *Electrical Identification*.
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.
- C. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section 017900, *Demonstration and Training*.

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DIVISON 26 SECTION 26 09 43
NETWORK LIGHTING CONTROLS
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SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. Provide all Labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

1.2 DESCRIPTION OF WORK

- A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal, and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturer's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product availability.
- B. The system shall include but not be limited to the following list: Pre-wired, microprocessor controlled relay or dimming panels with latching relays controlled via switches, photocells, occupancy sensors, time based control, building automation systems, thermostats, and other control devices.

1.3 SUBMITTALS

- A. Shop Drawings: Submit drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, occupancy sensors, photocells and other interfaces. Shop drawings shall indicate location of each device. Plans are diagrammatical. Electrical Contractor shall verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.
- B. Product Data: Submit for approval manufacturer's data for each type of product. Include construction details, descriptions, dimensions, and conductors and cables. Submit a complete bill of materials with part numbers, description and voltage specifications.
- C. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical riser diagrams are not acceptable.
 - 1. Show installation details for all devices including interconnection diagrams showing all field installed wiring.
 - 2. Include diagrams for power, signal and control wiring.
- D. Coverage Plans: Show locations and coverage patterns for all occupancy sensors.

- E. Programming Forms: Submit programming forms with complete information describing the operation of the network lighting control system and all other information necessary to show proper operation of the system.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation and maintenance manuals.

1.6 SUBSTITUTIONS

- A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent.
- B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within ten (10) days prior to bid.
- C. Acceptable Manufacturers
 - 1. Basis of Design
 - a. Acuity Brand Controls; nLight.
 - 2. Alternative Manufacturers
 - a. Wattstopper; Digital Lighting Management.
 - b. Hubbell NX
 - c. Eaton; Room Controller System.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

- A. System Architecture
 - 1. System shall have an architecture that is based upon wired networkable intelligent lighting control devices, standalone lighting control zones using distributed intelligence, and system backbone for remote, time based and global operation between control zones.
 - 2. The system shall be capable of providing individually addressable switching and dimming control of the following: control zones to include multiple switch legs or circuits, relays and dimming outputs from centralized panels and networked luminaires. System shall be capable of integrating indoor and outdoor lighting controls.

3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through software.
4. System shall be capable of 'out of box' sequence of operation for each control zone. Standard Sequence is:
 - a. All switches control all power packs in a zone.
 - b. All occupancy sensors automatically control all power packs in the control zone with a default time out.

B. Wired Network Control Zone Characteristics

1. Following proper installation and provisions of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming. The 'out of box' default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start up and programming requirements and to also have functional lighting control operation prior to system startup and programming.
2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone address.

C. System Integration Capabilities

1. The system shall be capable of interface with third party building management systems to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

2.2 DISTRIBUTED SYSTEM POWER, SWITCHING AND DIMMING CONTROLS

- A. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage class 2 power to the rest of the system.
- B. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
- C. Power packs shall accept 120 or 277 volt VAC and shall be plenum rated.
- D. Devices shall be UL listed for load and load types as specified on the plans.

2.3 WIRED NETWORK RELAY AND DIMMING PANEL

- A. Relays and dimming panels shall be capable of providing the required amount of relay capacity indicated as 4-relay, 8-relay, or 16-relay, as required per panel schedules shown on drawings, with an equal number of individually 0-10v dimming outputs.
- B. Standard relays used shall have the following required properties:

1. Configurable in the field to operate with normally closed or normally open behavior.
 2. Provide visual status of current state and manual override control of each relay.
 3. Be individually programmable.
- C. 0-10 VDC dimming outputs shall support a minimum of 100 mA sink current per output.
- D. Panel shall be UL924 listed for control of emergency lighting circuits.
- E. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays in the panels.

2.4 WIRED NETWORKED WALL SWITCHES, DIMMERS, SCENE CONTROLLERS

- A. Wall switches & dimmers shall support the following device options:
1. Number of control zones: 1, 2 or 4.
 2. Control Types Supported: On / Off or On / Off / Dimming.
- B. Scene controllers shall support the following device options:
1. Number of Scenes: 1, 2 or 4.
 2. Control Types Supported:
 - a. On / Off or On / Off / Dimming
 - b. Preset Level Scene Type
 - c. Reprogrammed or other devices within daisy-chained zone so as to implement user selected lighting scene.
 - d. Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones.

2.5 WIRED NETWORKED OCCUPANCY AND PHOTOSENSORS

- A. Sensors shall utilize passive infrared (PIR) or dual technology (microphonic/ultrasonic plus passive infrared) to detect both the major (walking) and minor (hand) motion as defined by NEMA WD-7 standards.
- B. Sensing technologies that are acoustically passive, meaning they do not transmit sound waves to any frequency, do not require commissioning. Ultrasonic based sensing technologies may require commissioning or sensitivity adjustment due to the active nature of their technology, if factory required.
- C. Sensor coverage shall be coordinated with the floor plans. Sensors shall be available in standard and extended range, as well as being available with option for High Bay mounting.
- D. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.

- E. Sensor mounting type shall match project design requirements as shown on the plans.
 - 1. Sensors shall have optional features for photosensor/daylight override, dimming control and low temperature/high humidity operations.
- F. The system shall support the following types of photocell-based control:
 - 1. On / Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
 - 2. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

2.6 WIRED NETWORKED AUXILIARY INPUT / OUTPUT (I/O) DEVICES

- A. Auxiliary Input / Output Devices shall be specified as an input or output device with the following options:
 - 1. Contact closure input
 - a. Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
 - 2. 0-10v analog input
 - a. Input shall be programmable to function as a daylight sensor.
 - 3. RS-232/RS-485 digital input
 - a. Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
 - 4. 0-10v dimming control output, capable of sinking a minimum of 20 mA of current
 - a. Output shall be programmable to support all standard sequence of operations supported by system.

2.7 WIRED NETWORKED WALL SWITCH SENSORS

- A. Wall switches sensors shall support the following device options:
 - 1. User input control types supported: On / Off or On / Off / Dimming.
 - 2. Occupancy Sensing Technology: PIR or Dual Technology.

3. Daylight Sensing Option: Inhibit Photosensor.

2.8 SYSTEM CONTROLLER

- A. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
- B. System Controller shall perform the following functions:
 1. Facilitation of global network communication between different areas and control zones.
 2. Time-Based control of downstream wired and wireless network device.
 3. Linking to an Ethernet network.
 4. Integration with Building Management System (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 5. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
- C. System Controller shall not require a dedicated PC or a dedicated cloud connection.
- D. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
- E. Devices shall have a standard and astronomical internal time clock.
- F. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 wired connection.
- G. System Controllers shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
 1. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the expansion I/O modules.
 2. BACnet/MSTOP shall support 9600 to 115200 baud.
 3. System Controllers shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building (B-BC) with outlined enhanced features.
 4. System controllers must support BACnet/IP Broadcast Management Device (BBMS) and Foreign Device Registration (FDR).
- H. Controllers shall be equipped for fail safe operation and shall be evaluated for this purpose.

- I. Controllers shall be activated by activation of the building fire alarm system.
- J. Controllers shall be equipped for activation by the building security system.

2.9 SYSTEM SOFTWARE INTERFACES

A. Management Interface

- 1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
- 2. Management interface must be compatible with industry-standard web browser clients.
- 3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface

- 1. System shall be capable of providing a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.

C. Visualization Interfaces

- 1. System shall be capable of providing an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones

- 1. System shall have option for a portable handheld application interface for standalone control zones.
- 2. Programming capabilities through the application shall include, but not be limited to, the following:
 - a. Switch/occupancy/photosensor group configuration.
 - b. Manual/automatic on modes.
 - c. Turn-on dim level.
 - d. Occupancy sensor time delays.
 - e. Dual technology occupancy sensors sensitivity.
 - f. Photosensor calibration adjustment and auto-setpoint.
 - g. Trim level settings.

E. Demand Response Client Interface

- 1. System shall be capable of receiving a signal from the Utility or through a BAS control sequence and initiating load shed in response.

- a. One full test of the Demand Response plan shall be performed and reports shall be included in the operations and maintenance manual.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITY

- A. Contractor shall provide the proper quantities and types of sensors for complete coverage of the areas to be controlled.
- B. Contractor shall properly install, wire, test and adjust sensors according to manufacturer instructions.
- C. Contractor shall be responsible for a complete operational system as specified.
- D. Contractor shall warrant all equipment and installation for a period of two (2) years from date of substantial completion. Contractor shall make any necessary adjustments to the system at no charge to the Owner during the warranty period.
- E. Contractor/Regional Sales Manager shall provide training to the Owner's representative in the use, operation, adjustment and maintenance of the equipment.
- F. Contractor shall set the sensors time delays per owner's instruction.

3.2 SYSTEM START UP AND COMMISSIONING

- A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION

DIVISION 26 SECTION 26 11 20
UTILITY-INCOMING SERVICE PROVISIONS
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SECTION 26 11 20 - 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 260500, *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.

1.3 RELATED WORK SPECIFIED ELSEWHERE IN DIVISION 26

- A. Section 260500 *Common Work Results for Electrical*.
- B. Section 260573 *Short Circuit Analysis, Coordination Study, and Arc Flash Hazard Analysis*.
- C. Section 260533 *Raceways and Boxes*.
- D. Section 262726 *Wiring Devices*.
- E. Section 260526 *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. The Contractor shall obtain all permits and permissions required.

1.5 SUBMITTALS

- A. Certificate of Compliance: Contractor shall submit a documentation 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. Photographs: Contractor shall submit photographs of each utility installation at each of the above described levels of completion and attach photographs to Certificate of Compliance for verification. Submit a minimum of six (6) color 4-inch x 6-inch photographs for each utility service.
- C. Submit Certificate of Compliance and photographs to each utility company for verification and approval.
- D. Include Certificate of Compliance, photographs, and utility company approvals in O&M Manual.
- E. 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 Delmarva Power Electric Service Manual.
- 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 DEC (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 grounding and clearances as required by the Utility.
- F. 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, 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.
- G. The Contractor shall ascertain from the utility companies, the available short circuit fault current.
- H. Equipment for Utility Company's Electric Metering:
 - 1. Comply with requirements of DEC.

2.2 TYPICAL INCOMING SERVICE PROVISIONS

- A. Pull Wire: 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. Manholes: Purchase from utility company. Provide as required.
- F. Underground Marking: Provide detectable warning tape over all conduits. Warning tape shall be as specified in Division 26 Section "Electrical Identification".
- G. Bends: Minimum 5 foot radius (horizontal) and 36-inch radius (vertical), unless otherwise noted.
- H. 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.
- I. 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 Wires: Pull wires 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 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 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

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LOW-VOLTAGE TRANSFORMERS
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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For Testing Agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturers: Square D Co./Group Schneider NA; Schneider Electric. Subject to compliance with requirements, provide products by one of the following:
 1. Powersmiths.
 2. Siemens Energy & Automation, Inc.

3. ABB-GE Electrification Equipment.
 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Aluminum or Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: None.
- F. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency: All transformers shall meet or exceed Department of Energy (DOE)) 2016 efficiency requirements per 110 C.F.R. &421/196 (2015).
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to K-factor of 13.

2. Indicate value of K-factor on transformer nameplate
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. 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-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

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SWITCHBOARDS
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SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- 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. Service and distribution switchboards rated 600 V and less.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Instrumentation.
 - 4. Control power.
 - 5. Accessory components and features.
 - 6. Identification.
- B. Related Requirements:
 - 1. Section 26 4343 "Surge Protection for Low Voltage Electrical Power Circuits."
 - 2. Division 23 Section 23 0900 "Instrumentation and Controls of HVAC and Plumbing Systems" for interface between electricity meters and building automation system

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
7. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and testing agency.
- B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components. Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Routine maintenance requirements for switchboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two 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. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Dimensional Limitations:

1. The switchboard dimensions shall be 78" wide, 24" deep or smaller. Larger units will not be accepted. The utility C/T section shall be configured for a side entry near the bottom due to the configuration of the existing secondary ductbank.

1.10 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace circuit breakers that fail in materials or workmanship within five years from date of Substantial Completion, and all remaining components for two years from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Nominal System Voltage: As indicated on the Drawings.
- D. Main-Bus Continuous: As indicated on the Drawings.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Customer Metering Compartment: Provide PowerLogic power meters (or equal). A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Provide for service entrance switchboard only.
- H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- I. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated copper feeder circuit-breaker line connections.
 - 2. Ground Bus: 1/4-by-2-inch- (6-by-50-mm), hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100A through 225 A, field adjustable short time and continuous current settings for circuit-breaker frame sizes 250A through 400A.
 2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings for circuit breaker frame sizes 600A and larger:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electricity Metering."
 - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current. Provide for main circuit breaker and where noted on the drawings.
 1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.

4. Accessories:
 - a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - b. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - c. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - d. Phase loss protection. Provide Taylor Phase-Guard Model P phase failure relay with adjustable pick-up, adjustable time delay output undervoltage phase failure protection to include autopower shunt trip with self-contained battery assisted capacitor trip, for feeder breakers indicated on the drawings. The shunt trip device shall be fully operable and capable of tripping the circuit breaker off the line during electrical fault conditions, regardless of the available level of prevailing electric power system voltage. This particular voltage protective feature is not to trip on a clean 3 phase power break. The phase-guard relay shall reset automatically after a fault has occurred, immediately when normal voltage conditions are restored.
5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 23 for monitoring by ATC system.
6. Control Voltage: 120-V ac.
- C. Fuses are specified in Section 26 2813 "Fuses."
- D. Provide an energy-reducing maintenance switch with local status indicator for all circuit breakers rated, or which can be adjusted to, 1200A and higher.
- E. Provide ground fault protection for all circuit breakers rated 1200A and higher.

2.3 INSTRUMENTATION

- A. Instrumentation Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for unit larger than 3 kVA.
- B. Multifunction Digital-Metering Monitor (provide for switchboard mains, and for feeders where indicated on the drawings): Microprocessor-based unit suitable for three- or four-

wire systems. Provide Square D PowerLogic PM5000 series power meter (or approved equal) with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Current, each Phase and Neutral: Plus or minus 0.075 percent.
 - b. Current demand (present, peak, predicted): Plus or minus 0.075 percent.
 - c. Voltages (line-line, line-neutral), per phase, min/max, unbalance: Plus or minus 0.075 percent.
 - d. Power: per-phase, total: Plus or minus 0.15 percent.
 - e. Power demand (present, peak, predicted): Plus or minus 0.15 percent.
 - f. Energy (real, reactive, apparent, in/out): ANSI 12.20 Class 0.2 and IEC 62053-22 Class 0.5S (real energy) and IEC 62053-23 Class 2 (reactive).
 - g. Power Factor (true and displacement, per phase, total, min/max): Plus or minus 0.2 percent from 0.5 leading to 0.5 lagging.
 - h. Frequency (present, min/max): Plus or minus 0.01 Hz.
 - i. Basic THD on voltage and current, per phase, min/max, custom alarming.
 - j. Individual harmonic magnitudes and angles on voltage and current, up to the 31st harmonic.
 - k. Onboard data and event logging, stored in nonvolatile onboard memory. Logging capacity shall be 80kB minimum with a battery-backed internal clock.
 - 1) Minimum/maximum log: for all instantaneous readings, logs worst phase since last reset including date and time stamp.
 - 2) Maintenance log: records date and time of energy, I/O and demand resets, firmware downloads, power outages and option module changes.
 - 3) Alarm log: records all user-defined alarm conditions with date/time stamping to 1 second resolution.
 - 4) Billing log and energy per interval: logs kWh in and total, kVARh in and total, kVAh total, PF total, kW and kVar demand. Logs at 1 minute, daily and monthly intervals. Energy per interval log tracks usage and cost for up to three user-defined shifts per day.
 - 5) Customizable data log which can record up to 96 user-defined parameters.
 - l. Digital and analog inputs and outputs: provide a single digital status/counter input and digital (KY type) output on the meter unit, with two expansion modules (including logging or communications modules). Expansion modules may be digital and analog I/O as required.
 - m. Alarm and Control Functions: over 50 definable alarm conditions with 1 second response time can be used to log critical events or to perform control functions. Trigger on over or under conditions on any measured parameters, phase unbalance, digital input changes and more. Multiple alarm scan can be defined with each alarm individually configured with pickup setpoint, dropout setpoint and delay. Each alarm can be assigned one of four priority classes.

- n. Communications: provide a PM8ECC Ethernet communications card: 10/100 Base-T UTP port supporting Modbus TCP/IP communications. Full-function embedded web server providing standard web browser access to meter data, and the ability to email on an alarm from the host meter. RS-485/232 prot, 2- or 4- wire, Modbus (ASCII and TRU) master port providing Ethernet-to-serial line gateway functionality. Supports Transparent Ready – Level 1 (TRE) functionality. Provide all components required to communicate with building energy management system.
 - o. Special Features
 - 1) Hour counter: load running time in days, hours and minutes.
 - 2) Downloadable firmware: meters can be updated with the latest features by downloading them from www.powerlogic.com.
2. Mounting: LCD display and control unit flush or semiflush mounted in instrument compartment door.

2.4 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. 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.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Additional connections to metering systems, where applicable, shall be done in the field by the manufacturer's start-up service group.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 STARTUP SERVICES FOR MONITORING

- A. Engage a factory-authorized service representative to perform startup service.
- B. Train Owner's maintenance personnel on procedures and schedules for energizing and de-energizing, troubleshooting, servicing and maintaining equipment and schedules.
- C. Verify that the meters are installed and connected according to the Contract Documents.
- D. Verify that the electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
- E. Complete installation and startup checks according to manufacturer's written instructions.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units. Provide a minimum of 4-hours on-site training.

END OF SECTION

DIVISION 26 SECTION 26 24 16
PANELBOARDS
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SECTION 26 24 16 - 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 distribution panelboards, lighting and power panelboards and fusible circuit breaker panelboards with associated auxiliary equipment rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 26 Section 264300, Surge Protection Devices.

1.3. SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
- C. Qualification Data: For qualified testing agency.

- D. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Time current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4. QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.5. EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: 2 spares of each type for panelboard cabinet lock.

2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6. DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7. PROJECT CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet (2000 m).

1.8. COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9. WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS FOR PANELBOARDS AND LOAD CENTERS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Enclosures: Flush- and surface-mounted cabinets. Piano hinged doors and covers.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
 - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 2. Hinged Front Cover: Entire front trim piano hinged to box and with piano hinged door within hinged trim cover.
 3. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
 5. Multiple-Section Panelboards shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trim, and doors shall be of the same size. Main lugs and busses of each section shall be rated as indicated on the Drawings. Where main breakers are indicated in multi-section panelboards, the main breaker shall be contained in one section with through-feed lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All busses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections, in addition to being balanced over the phases.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- I. Provide integral surge suppression device for each panel with SPD disconnect indicated in schedule on the drawings.

2.2. LIGHTING AND APPLIANCE PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 1. ABB-GE Electrification Equipment
 2. Eaton Corp.; Cutler-Hammer.
 3. Siemens Energy & Automation, Inc.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- E. Doors: Piano hinged doors and covers. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3. DISCONNECTION AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100A through 225A, field adjustable short-time and continuous current setting for frame sizes 250A and larger.
 - 2. GFCI Circuit Breakers: Single-and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Ground Fault Equipment Protection (GFEP) Circuit Breakers; Class B Ground Fault Protection (30-mA trip).
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - j. Handle Clamp: Loose attachment for holding circuit breaker handle in ON position for breakers serving clocks, telephone, and communications

equipment, refrigerators, exit signs, fire alarm systems, controls, etc., to prevent accidental operation.

2.4. ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation per manufacturer's recommendations.
- B. Portable Test Set: Provide for testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.
- I. Air distribution panels shall be installed on galvanized formed steel channels designed to distribute the weight on the supporting wall.

- J. Conduits entering the tops and bottoms of flush panels shall be located back from the front ledge of the panels to allow approximately 2-inches between the finished wall and the edge of the conduits.
- K. Where panelboard is mounted flush in a wall or partition, provide 3/4-inch empty conduit, from panelboard to ceiling space for each three or less spare single pole breakers and/or spaces in the panel unless otherwise noted on the drawings.
- L. Surge protective device units shall be installed immediately above or below panelboard enclosure, per manufacturer's recommendations, connected to circuit breaker disconnecting means with lead length of conductors less than 18 inches.

3.3. IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5. ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
 - 5. Set field-adjustable circuit-breaker trip ranges as specified in Section 260.

3.6. PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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WIRING DEVICES
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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Toggle switches.
 - 4. Wall plates.
 - 5. Emergency pushbuttons.
 - 6. Protective wire guards.
- B. Related sections include the following:
 - 1. Section 260923 – Lighting Control Devices.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

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 available manufacturers' names:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, Tamper-Resistant 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; BR20*.
 - b. Leviton; 5362-SG*.
 - c. Pass & Seymour; TR5262*.

2.3 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. GFCI Convenience Receptacles, Tamper-Resistant 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFTR20.
 - b. Pass & Seymour; 2095TR.
 2. Receptacle(s) shall also be weather-resistant type for exterior applications.

2.4 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.5 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade, or as noted on the Drawings.
1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 TOGGLE SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

- d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Lighted Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell HBL1221ILC (single pole) or approved equal.
2. Description: Handle illuminated when switch is off.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

D. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

E. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.7 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
3. Material for Shop Areas: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.

4. Material for Unfinished Spaces: Galvanized steel.
 5. Color: Matches wiring device, except as otherwise indicated.
 6. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Material for Damp Locations: Heavy-duty die-cast zinc/aluminum construction listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be equipped with one or more lift cover(s) equipped with stainless steel springs. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch.
1. Duplex Receptacle, 2 Self-Closing Lids – Pass & Seymour Model No. CA8GH (Horizontal) or approved equal.
 2. GFCI Receptacle, 1 Self-Closing Lid – Pass & Seymour Model No. CA26GH (Horizontal) and Pass & Seymour Model No. CA26GV (Vertical), or approved equal.
 3. Toggle Switch – Pass & Seymour Model No. CA1GL or approved equal.
 4. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.
- C. Material for Wet Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles 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 toggle switches shall be equipped with actuating levers and shall mount directly over the switch.
1. Duplex/GFCI Receptacle - Pass & Seymour Model No. WIUCAST1 or approved equal.
 2. Toggle switch – Pass & Seymour Model No. CA1GL, or approved equal.
 3. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.
- D. Provide jumbo size plates for outlets installed in masonry walls.

2.8 EMERGENCY PUSHBUTTONS

- A. General:
1. Emergency pushbuttons shall be Stopper Station with Bopper 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. Standard switch shall include one N.O. and one N.C. contact.
4. Switch 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. "Emergency Utilities Off" (used when shutting off multiple utilities, i.e. power, air, water, and/or gas)

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. Lifetime guarantee against breakage of polycarbonate from normal use.

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.

2.9 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices: White, or as specified by architect, unless otherwise indicated or required by NFPA 70 or device listing.

2.10 PROTECTIVE WIRE GUARDS

- A. Provide protective wireguards 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. Clocks
 - 3. Fire Alarm Pull Stations
 - 4. Thermostats
 - 5. Smoke/Heat Detectors
 - 6. Speakers
 - 7. Fire Alarm Audio/Visual Devices (Strobe, Horn, etc...)
 - 8. Exit Signs
 - 9. Emergency Lights
 - 10. Telephones
 - 11. Data Outlets
 - 12. Security Devices/Motion Detectors
 - 13. Wiring Devices
 - 14. Emergency Shut-Off Stations
 - 15. Other Devices as required by Owner
- C. Guard shall be fabricated from 1/4-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guard 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. Protective Devices 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 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Division 16 Section "Identification for Electrical Systems."
1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate. Light switches shall be labeled as to lights controlled and with circuit number and panel identification.

2. Receptacles: 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. Protect label from damage during construction. Replace all damaged and unclear labels.
3. Mark all conductors with the panel and circuit number serving the device at the device.
4. 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.

3.4 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. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
- D. 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.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.

- 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

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FUSES
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SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fuses.
- 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 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Coordination charts and tables and related data.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 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: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 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. Edison Fuse, Inc.
 - 3. Ferraz Shawmut. Inc.
 - 4. Littelfuse, Inc.
- 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class J, time delay.
 - 2. Motor Branch Circuits: Class RK1, time delay.
 - 3. Other Branch Circuits: Class RK1, time delay, time delay.
 - 4. Control Circuits: Class CC, time delay.

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. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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ENCLOSED SWITCHES AND CIRCUIT BREAKERS
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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.6 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).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 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: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.2 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, lockable in either open or closed positions, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. Provide where neutral wire is provided.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary. Contacts would reactivate before blades open as indicated on the Drawings. Provide where indicated on the drawings.
5. Lugs: Compression type, suitable for number, size, and conductor material.
6. Accessory Control Power Voltage: Remote-mounted and powered; 120-VAC. Provide as required with auxiliary contact kit. Provide where indicated on the drawings.

2.3 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable in either open or closed position, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. Provide where neutral wire is provided.
 3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contacts, arranged to activate before switch blades open, where indicated in the Drawings. Provide where indicated on the drawings.
 4. Lugs: Compression type, suitable for number, size, and conductor material.
 5. Accessory Control Power Voltage: Remote mounted and powered; 120 VAC. Provide as required with auxiliary contact kit. Provide where indicated on the drawings.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. ABB-GE Electrification Equipment.
 - 3. Siemens Energy & Automation, Inc.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact, as indicated on the drawings. Provide as indicated on the drawings.
 - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay. Provide as indicated on the drawings.
 - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts, where indicated on the drawings. Provide as indicated on the drawings.
 - 7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped, where indicated on the drawings. Provide as indicated on the drawings.
 - 8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac, as required. Provide as indicated on the drawings.
 - 9. Provide with lockable handle, lockable in either open or closed position.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4, 4X, stainless steel.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas: NEMA 250, Type 7.
 7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
- B. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- C. Operating Mechanism: The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate

from those of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed

- manufacturer's published time-current characteristic tolerance band, including adjustment factors.
- 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
- f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - h. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

DIVISION 26 SECTION 26 29 13
ENCLOSED CONTROLLERS
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SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
- B. Related Sections include the following:
 - 1. Mechanical Divisions for "Variable Speed Drives" and "Power Factor Correction Capacitors".

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control test reports.

- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. ABB-GE Electrification Equipment.
 - 3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 4. Siemens/Furnas Controls.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.
 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Control power transformers shall have primary and secondary fuse protection.
 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 1. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch unless otherwise noted on the drawings.
 2. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 3. MCP Disconnecting Means: UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

- A. Description: Surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4. 4X, stainless steel.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas: NEMA 250, Type 7.

7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
- B. Provide lockable handle for combination starter and disconnects that accepts three padlocks and interlocks with cover in closed position.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Push-to-Test Red "Power Available" and Green "Running" non-incandescent, Pilot Lights, and Hand-Off-Automatic Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Control Relays: Two (2) NO/NC auxiliary contacts and adjustable time-delay relays as required by automatic control sequence.
- D. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. 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 complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

- C. Install Power Factor Correction Capacitors furnished under Mechanical Divisions with disconnects, overcurrent protection, wire, conduit and ground for capacitor enclosure, all in accordance with the recommendations of the capacitor manufacturer and the National Electric Code.
- D. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.4 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Section 260553 "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 3. Electrical Tests:
 - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation

- resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
- b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

DIVISION 26 SECTION 26 43 13
SURGE PROTECTIVE DEVICES
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END OF SECTION 6

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SECTION 26 43 13 - SURGE PROTECTIVE 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. Description: This section describes the materials and installation requirements for integral and stand alone Surge Protective Devices (SPDs) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching. SPD's shall be installed integral with equipment unless otherwise indicated.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. NRTL: Nationally recognized testing laboratory.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge protective device.
- I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- K. VPR: Voltage protection rating.

1.4 REFERENCES

- A. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
- B. ANSI/IEEE C62.45 - IEEE Recommended Practice on Surge Suppressor Testing.
- C. FIPS Pub 94 (1983) - Guide on Electrical Power for ADP Installation.
- D. National Electrical Code - Article 285
- E. National Fire Protection Association - NFPA-20, NFPA-70, NFPA-75, NFPA-78.
- F. NEMA LS-1 Low Voltage Surge Protection Devices.
- G. NEMA 250 - Enclosures for Electrical Equipment.
- H. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- I. UL 1283 - Electromagnetic Interference Filters.
- J. UL 1449, Fourth Edition - Surge Protective Devices.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Indicate overcurrent protection requirements.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For surge protective devices to include in the maintenance manuals specified in Division 01.
- D. Warranties: Special warranties as specified in this Section.
- E. The submittals shall include:
 - 1. UL 1449, Fourth Edition Listing documentation verifying:
 - a. Short Circuit Current Rating (SCCR)
 - b. Voltage Protection Ratings (VPRs) for all modes
 - c. Maximum Continuous Operating Voltage (MCOV) rating
 - d. I-nominal (I-n) rating
 - e. Type 1 Device listing
 - 2. VPR, MCOV, I-n and Type 1 information is posted at www.UL.com, under Certifications. SCCR's are posted in manufacturer's UL documents.
 - 3. UL Standard 1283 Listing, documentation.

4. UL data and visual inspection take precedence over manufacturer's published documentation.
- F. Submittals shall include shop drawings including the following:
1. Manufacturer's installation instruction manual and line drawings detailing dimensions and weights of enclosure.
 2. Internal wiring diagram illustrating all modes of protection in each type of SPD required.
 3. Wiring diagram showing all field connections and manufacturer's recommended wire and circuit breaker sizes.
- G. Upon request, an encapsulated but complete SPD shall be presented for visual inspection. MOV type & quantity shall reflect kA ratings on product data sheets, verification of diagnostic monitoring, thermal & overcurrent protection, etc.

1.6 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is 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.
 3. Comply with NFPA-70.

1.7 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 under requirements of the Contract Documents.**
- B. **Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of Surge Protective Devices that fail in materials or workmanship within the specified warranty period.**
1. **Warranty Period: Five (5) years (minimum) from date of Substantial Completion.**

PART 2. PRODUCTS

2.1 MANUFACTURERS

- A. Provide integral SPD from equipment manufacturer that meets the following requirements.

2.2 SURGE PROTECTIVE DEVICES

- A. 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 NEC 285.6.
- B. SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnects do not meet the intent of this specification.
- C. SPD shall be UL labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
- a. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- D. Minimum surge current capability (single pulse rated) per phase shall be:

Service Entrance or Transfer Switch:	300kA

- E. SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- F. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>System Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>L-L</u>	<u>N-G</u>
480Y/277	1200V	1200V	1800V	1200V

(Mode VPRs verifiable at UL.com. Numerically lower is allowed/preferred; old-style Suppressed Voltage Ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing)

- G. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
480Y/277	15%	320V

- H. SPD shall include a serviceable, replaceable module (excluding Branch).
- I. SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

- J. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED. SPD shall include an audible alarm with on/off silence function and diagnostic test function (excluding branch).
- K. SPD shall be provided with the following options:
 - 1. One (1) set of NO/NC dry contacts
 - 2. Surge event counter with back-up power source
 - 3. Integral disconnect switch.

2.3 ENCLOSURES

- A. Mount integral in panel enclosure unless otherwise indicated. For applications where stand alone mounting is indicated or required, provide the following enclosures:
 - 1. Indoor Enclosures: NEMA 250, Type 1.

PART 3. EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. 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.

3.2 FIELD QUALITY CONTROL

- a. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Before energizing electrical circuitry, verify that the unit voltage and connecting equipment voltage is the same.
 - 3. Inspect anchorage, alignment, grounding, and clearances.
 - 4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

- b. An SPD will be considered defective if it does not pass tests and inspections.
- c. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- a. Complete startup checks according to manufacturer's written instructions. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- b. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- c. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- a. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

DIVISION 26 SECTION 26 51 00
INTERIOR LIGHTING
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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures.
 - 2. LED lamps and drivers.
 - 3. Emergency lighting units.
 - 4. Exit signs.
 - 5. Integral Emergency Lighting Power Units.
 - 6. Lighting fixture supports.
- B. Related Sections:
 - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Division 26 Section "Wiring Devices" for snap switches and wall switches.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. Fixture: See "Luminaire."
- D. IP: Ingress Protection or International Protection Rating.
- E. LED: Light emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, driver, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Drivers, including energy-efficiency data.
 - 4. Energy-efficiency data.
 - 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project. Comply with IES LM-79, IES LM-80.
 - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, and mounting and attachment details.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
 - 1. Lamps and drivers, installed.
 - 2. Cords and plugs.
- D. Installation instructions.
- E. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, from manufacturer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 2. Warranty Period for Emergency Battery Pack and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Electronic Drivers: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
 - 5. LED Modules (light engine and driver): Furnish at least (1) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that 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. Basis of Design Product: The design of each item of interior luminaire is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.
- G. Recessed luminaires shall comply with NEMA LE 4.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-metal hydride type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, nickel-cadmium type.
 2. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 LED LAMPS/LUMINAIRES

- A. LED Luminaires: A LED luminaire consists of LED light engine and driver, heat-sink, fixture housing, and optic assembly where applicable.
1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.
 2. Life and Lumen Maintenance: L70 lamp life of 50,000 hours.
 3. CRI and CCT: 3500 deg K (+/- 275 K) CCT and greater than 80 CRI.
 4. Transient Voltage Protection: Rated to withstand 2.5 kV of transient line surge.
 5. Photometric Data and Test Reports: Comply with IESNA LM-79-19, IESNA LM-80-15, and ANSI C78.377-17.
 6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.

7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.
8. Five-year warranty on luminaire including LED light engine and driver.
9. Power Factor: 90 percent minimum.
10. Total Harmonic Distortion Rating: Less than 20 percent.
11. RoHS compliant.
12. Sound Rating: Class A.
13. Overload, short circuit, and thermal protection.
14. Comply with UL 1598-14 NMX-J-307/1-ANCE/C22.2 NO.250-0-14, *Luminaires, LEDs*.

2.6 INTEGRAL EMERGENCY LIGHTING POWER UNITS

- A. Provide emergency lighting power supply units for fixtures indicated on the drawings with integral emergency battery unit as specified herein.
 1. Each fixture indicated to be provided with an emergency driver shall be provided with an emergency power supply unit which consists of a package assembly containing a high-temperature maintenance-free lithium ion battery, a rectifier/battery charger, a DC to AC inverter contained in one metal enclosure. Emergency drivers shall be provided in conjunction with the AC LED driver provided with the fixture, compatible with the driver output current (max 5A). The battery shall have a normal life expectancy of 10 to 15 years with sufficient capacity to operate the lamp load at full normal brightness for 90 minutes. Units shall be UL approved for compliance with UL Standard 924 "Emergency Lighting and Power Equipment."
 2. Each unit shall be unconditionally guaranteed for a period of three years, with an additional three year pro-rated guarantee on the storage battery.
- B. Operating Modes
 1. Each emergency power supply unit shall automatically operate the lamp in the event of an AC power system failure for 90 minutes. When AC power is restored, the emergency power supply unit shall automatically return to the charging mode.
 - a. MODE 1: Lamp is controlled by a switched AC ON/OFF circuit. Lamp automatically turns ON when AC power is lost. The unit is shipped from the factory connected for this mode of operation.
 - b. MODE 2: Same as MODE 1 except lamp does not automatically turn ON when AC power is lost. This mode is established by adding a jumper between the AUTO and GND terminals.

- c. MODE 3: The unit can be used to provide continuous unswitched, uninterruptible light. A switched AC circuit is not used for this mode. To establish this mode of operation, connect a jumper between the OVER and GND terminals.
 - d. MODE 4: The unit can be used to provide an unswitched light which is normally OFF but which automatically turns on when AC power is lost. This mode of operation is established by connecting only the unswitched AC circuit to the power supply unit.
 - e. MODE 5: Lamp is turned on by external switch or relay contacts. The switched AC ON/OFF circuit is optional in this mode. The switch contacts "override" the (optional) switched AC circuit to turn the lamp on. In order for the lamp to be OFF, the external switch contacts must be open AND the switched AC circuit (if used) must be OFF. This mode is established by connecting the switch contacts to OVER and GND. In this mode, the lamp will also be automatically turned ON in the event of AC power failure, unless this feature is disabled by connecting a jumper between the AUTO and GROUND terminals.
- C. Power supply units for emergency lighting shall be provided with remote test switch to be mounted flush in ceiling adjacent to fixture. Power supply units shall be Bodine 10W BSL10T3U series self-testing/self-diagnostic Class 2 output, Emergi-Lite (unless otherwise noted), or the same manufacturer of the lighting fixture as noted in the Lighting Fixture Schedule.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug EXECUTION.

2.8 GENERAL

- A. Comply with NECA/IESNA 500-2006 "Standard for Installing Indoor Commercial Lighting systems."

2.9 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Drivers: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.
- D. Integral Emergency Lighting Power Units:
 - 1. Power supply units for emergency lighting shall be mounted on the top of the fixture housing as recommended by the manufacturer. If required, the units shall be permitted to be remote mounted up to 50 feet from the fixture per manufacturer's distant limitations, mounted on the building structure above the ceiling space. Where units are remote mounted, the final four-foot length of connecting raceway shall be Greenfield flexible metallic conduit to facilitate fixture removal.
 - 2. Note that wherever an emergency lighting power supply unit is used in a circuit controlled by a light switch, a four wire connection to the AC power source is required - the switched wire, the hot wire, the neutral and ground.
- E. Lay-in Ceiling Luminaire Supports: Use grid as a support element.
 - 1. Install ceiling support system wires (Solid#12AWG safety wire), independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide

damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows: 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. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

2.10 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

2.11 FIELD QUALITY CONTROL

- A. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

2.12 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260923 "Lighting Control Devices."

2.13 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust aimable luminaires in the presence of Architect.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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FIRE ALARM SYSTEM
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SECTION 28 31 11 – 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. This specification provides the requirements for the installation, programming and configuration of an extension of the existing Fire Alarm System. The system shall include, but not be limited to: Fire Alarm Control Panel, Automatic and Manually activated alarm Initiating and Indicating Peripheral Devices and Appliances, conduit, wire and accessories required to furnish a complete and operational Fire Alarm System. System shall include, but not be limited to, the following:

- 1. Carbon monoxide detectors.

- 2. Duct smoke detectors.

- B. The system shall include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, alarm initiating devices, alarm indicating devices, and control equipment, and all other accessories and miscellaneous items required for an operating system.

- C. The Fire Alarm 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 Fire installed.

- D. Existing system devices shall be re-used and maintained fully operational unless otherwise noted. Reconnect and reprogram existing system circuits/devices as required, including interface with security system for system monitoring at Pulaski Highway facility, for a fully functional system.

Test system prior to performing any modifications and report any defects, etc. to the owner in writing. Any defects, malfunctions of the system not reported in advance of performing work shall be the responsibility of the contractor to correct.

- E. All related work specified in other sections shall be properly coordinated with the fire alarm equipment.

1.3 REFERENCES

- A. The system, equipment, installation, and operation shall comply with the current provisions of the following standards and publications.

- 1. National Electric Code, Article 70.

2. National Fire Protection Association Standards:
 - a. NFPA72 National Fire Alarm Code
 - b. NFPA 90A Air Conditioning & Ventilation Systems
 - c. NFPA101 Life Safety Code
3. Local and State Building Codes.
4. Local Authorities Having Jurisdiction.
5. Underwriters Laboratories Inc.: The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:
 - a. UL 864/UOJZ, APOU - Control Units for Fire Protective Signaling Systems.
 - b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 - c. UL 268A - Smoke Detectors for Duct Applications.
 - d. UL 217 - Smoke Detectors Single Station.
 - e. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 - f. UL 228 - Door Holders for Fire Protective Signaling Systems.
 - g. UL 464 - Audible Signaling Appliances.
 - h. UL 1638 - Visual Signaling Appliances.
 - i. UL 38 - Manually Activated Signaling Boxes.
 - j. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
 - k. UL 1971 - Standard for Signaling Devices for the Hearing Impaired.
 - l. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
 - m. UL 1711 - Amplifiers for Fire Protective Signaling Systems.
 - n. UL Fire Protection Equipment Directory.
 - o. UL Electrical Construction Materials Directory.
6. Americans with Disabilities Act (ADA)
7. International Standards Organization (ISO)
 - a. ISO-9000
 - b. ISO-9001
8. Factory Mutual Approval Guide.
9. State of Delaware Fire Prevention Code.
10. American Insurance Association Fire Protection Code (Article 14).
11. Delaware Occupational Safety & Health Act.
12. International Building Code (IBC).

1.4 DEFINITIONS

- A. FACP: Fire Alarm Control Panel.

- B. HLI: High Level Interface.
- C. NICET: National Institute for Certification in Engineering Technologies.

1.5 ACTION SUBMITTALS

1. 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.
2. 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 plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Locate detectors according to manufacturer's written recommendations.
 12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

13. 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 diagram
 14. Submit wiring diagrams for all equipment connected to fire alarm system. Examples are monitoring of hood extinguishing systems, sprinkler systems, HVAC control, damper control, elevator recall and elevator power shunt trip of the elevator system control.
3. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - a. Secure permits and approvals prior to installation.
 - b. Prior to commencement and after completion of work, notify Authorities Having Jurisdiction.
 - c. Submit letter of approval for installation before requesting acceptance of system.
 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.7 WARRANTY

- A. For materials and workmanship for a period of two years from final system acceptance.

1.8 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 "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. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.9 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. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

4. Keys and Tools: One extra set for access to locked or tamperproofed components.
5. Audible and Visual Notification Appliances: One of each type installed.
6. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.11 PROJECT CONDITONS

- A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.12 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: Five years from date of Substantial Completion.

PART 2. PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as extension of existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected systems:

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. Carbon monoxide detectors.
 - 2. Valve supervisory switch.
 - 3. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
 - 4. Duct smoke detectors.
 - 5. Independent fire-detection and -suppression systems.
 - 6. User disabling of zones or individual devices.
 - 7. Loss of communication with any panel on the network. System trouble signal initiation shall be by one or more of the following devices and actions:
- B. System Supervisory Signal Actions:
 - 1. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, and remote annunciators.
 - 2. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 - 3. Transmit system status to building management system.
 - 4. Display system status on graphic annunciator.

2.3 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to carbon monoxide detection system.
 - 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Testable by introducing test carbon monoxide into the sensing cell.
 - 3. Detector shall provide alarm contacts and trouble contacts.
 - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - 5. Comply with UL 2075.
 - 6. Locate, mount, and wire according to manufacturer's written instructions.
 - 7. Provide means for addressable connection to carbon monoxide detection system.
 - 8. Test button simulates an alarm condition.

2.4 DUCT SMOKE DETECTORS

- A. Description: Photoelectric-type, duct-mounted smoke detector.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72.
 - b. UL 268A.
 - 2. General Characteristics:
 - a. Detectors must be four-wire type.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
 - h. Each sensor must have multiple levels of detection sensitivity.
 - i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.5 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

- A. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72.
 - 2. General Characteristics:
 - a. Include address-setting means on module.

- b. Store internal identifying code for control panel use to identify module type.
- c. Listed for controlling HVAC fan motor controllers.
- d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
- e. Integral Relay: Capable of providing direct signal to lighting control system to turn ON egress lighting.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
- f. Control Module:
 - 1) Operate notification devices.
 - 2) Operate solenoids for use in sprinkler service.

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. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch (9100 mm) long must 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.

3.3 PATHWAYS

- A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
 1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted red enamel

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to 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.

3.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 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.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION