



JOHNSTON COUNTY PUBLIC SCHOOLS
Clayton Middle School
AHU 16 and 17 Replacement

Dewberry Project No. 50185618
JCPS Clayton Middle School AHU 16 and 17 Replacement

PROJECT MANUAL

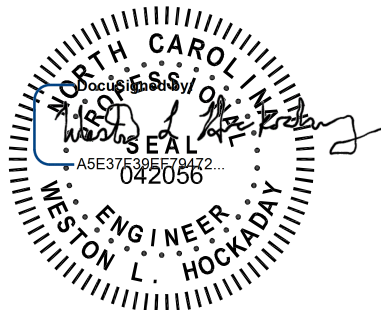
PREPARED FOR:

Johnston County Public Schools
Facilities and Construction
2320 US HWY 70 Business East,
Smithfield, NC 27577

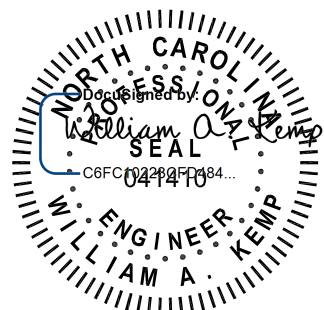
March 31, 2025

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3/28/2025



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Johnston County Public Schools
Clayton Middle School AHU 16 and 17 Replacement

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ADVERTISEMENT FOR BID
Johnston County Public Schools
Clayton Middle School AHU 16 and 17 Replacement

Sealed bids from licensed contractors will be received by Johnston County Public Schools, Smithfield, North Carolina on **Tuesday, April 22, 2025** for furnishing of labor, material, and equipment for the JCPS Clayton Middle School AHU 16 and 17 Replacement. Bids will be received up to **2:00 PM** from Single Prime bidders at which time and place all bids will be publicly opened and read aloud. Deliver bids to the **Johnston County Public Schools Simpson's Building located at 2320 US HWY 70 Business East, Smithfield, NC 27577**. USPS mail is automatically routed to our PO Box which creates issues for large packages, do NOT use this method to send proposals.

- No bid may be withdrawn after the scheduled closing time for the receipt of bids for a period of sixty (60) days.
- Bid security required is 5% of the bid in cash, certified check, or Bid Bond.
- Performance and Payment Bonds for 100% of the contract amount will be required.
- Johnston County Public Schools reserves the right to reject any and all bids and to waive informalities or irregularities.

Minority Business Participation: Bidders shall note that compliance with County of Johnston MBE policies and the North Carolina Statute 143-128.2 (c) are required for this project.

Iran Divestment Act: Bidders shall note that the submission of a bid constitutes the bidder's certification to the State Treasurer that, as of the date of bid, it is not listed on the Final Divestment List created and maintained by the North Carolina Department of State Treasurer (the "Treasurer's Office") pursuant to the Iran Divestment Act of 2015, Chapter 147-Article 6E of the General Statutes of North Carolina (the "Iran Divestment Act").

Project scope: Demolition and Installation of owner furnished air handling unit 16 and 17 along with additional work to meet project drawings and specifications starting in July and finishing in August.

Pre-Bid Conference: Scheduled for **Tuesday, April 8th, 2025 at 1:30 PM.** Pre-bid meeting will be held at the Clayton Middle School at 490 Guy Road, Clayton, NC 27520. The project Designer or Designer's representative will be available to answer questions. **It is MANDATORY that prime bidders attend the Pre-Bid Conference at the site prior to bidding.**

For information regarding this bid, drawings, and specifications, please contact:

Designer Contact Information:

Dewberry Engineers Inc.
Weston Hockaday, Project Manager
whockaday@dewberry.com
(cell) 919-524-3668

Owner Contact Information:

Johnston County Public Schools
Joshua Woodard, Project Manager
joshuawoodard@johnston.k.12.nc.us
919-934-2021, ext. 7044

Thank you for your consideration.

Signed: Joshua Woodard
HVAC Coordinator
Johnston County Public Schools, Smithfield, North Carolina

Advertisement:

HEADER:

ADVERTISEMENT FOR BIDS - JOHNSTON COUNTY PUBLIC SCHOOLS – Clayton Middle School AHU 16 and 17 Replacement

Description:

Sealed proposals from contractors will be received on Tuesday, April 22nd, 2025, in the office of the Johnston County Public Schools Simpson's Building located at 2320 US HWY 70 Business East, Smithfield, NC 27577, for the completion of the JCPS Clayton Middle School AHU 16 and 17 Replacement project. All bids will be opened and read aloud starting at 2:00 p.m. Mandatory pre-bid meeting will be held April 8th, 2025 at 1:30pm at Clayton Middle School at 490 Guy Road, Clayton, NC 27520. For more information on requirements visit <https://www.johnston.k12.nc.us/page/facilities-design-and-construction>. Minority and women-owned businesses are encouraged to participate. The Johnston County Public Schools reserves the right to reject any and all bids.

SECTION A

INFORMATION FOR BIDDERS

TAKE NOTE: Changes have been made to these documents since the last edition. Paragraph A-18 entitled Equal Products And Substitutions has been modified.

A-1. SUBMISSION OF BIDS AND BID OPENING:

- A. Bids will be received by Johnston County Public School System and will be opened and read at the times and places set forth in the Advertisement for Bids. Bidders, or their representative, and other interested persons may be present at the opening of proposals. Note that the Owner of this Project is Johnston County, by and through its authorized agent, the Johnston County Board of Education. The Project will be administered by the Facilities Services Department of the Johnston County Public Schools.
- B. The envelopes containing the bids must be sealed and addressed to Johnston County Public Schools, Facilities and Construction Dept., **2320 US HWY 70 Business East, Smithfield, NC 27577** and marked on the outside of the envelope "Proposal for (General, Plumbing, Etc.) Contract, (Name of Project and Project Number), with the name of the Bidder and his North Carolina State Contractor's Registration Number.
- C. The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids. When the Owner solicits single-prime bids, the Owner shall establish separate deadlines for the submission of single-prime and multiple-prime bids.
- D. In accordance with the Advertisement for Bids, bids will be received for any or all of the following multiple prime construction contracts: General Construction, Mechanical Construction, Plumbing Construction and Electrical Construction. If so advertised, separate bids will also be received for a Single Prime Construction Contract.

A-2. BIDDING DOCUMENTS:

- A. Bidding Documents include the Advertisement for Bids, Information for Bidders, Form of Proposal, the Bid Security and the proposed Contract Documents, including any Addenda issued prior to receipt of bids. All requirements and obligations of the Bidding Documents are hereby incorporated by reference into the Contract Documents and are binding on the Successful Bidder upon award of the contract.
- B. Bidders may obtain complete sets of the bidding Documents from the issuing office designated in the Advertisement for Bids in the number and for the price, if any, stated therein.
- C. Bidders shall use complete sets of Bidding Documents in preparing Bids; neither the Owner nor the Design Consultant shall assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- D. The Owner in making copies of the Bidding Documents available on the above terms does so only for the purpose of obtaining Bids on the Work and does not confer a license or grant for any other use.

A-3. DEFINITIONS:

A. THE BID:

A Bid is a complete and properly signed proposal to do the work or designated portion thereof for the sums stipulated therein, submitted in accordance with the Bidding Documents and North Carolina law.

B. BASE BID:

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

C. ALTERNATES:

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

A-4. QUALIFICATION OF BIDDER:

- A. If requested by the Owner prior to the signing of the contract, the successful Bidder shall submit a statement of work to be performed by his own forces.
- B. Prior to Contract award or within seven days of the Owner's request to do so, the successful Bidder shall be prepared to demonstrate that his present organization, direct labor force and prior work experience is of adequate size and development to maintain responsible control of the project and to schedule, coordinate and perform the work in an expeditious manner and in accordance with the Contract Documents.
- C. Bidders, whether residents or nonresidents in North Carolina will be required to show evidence of a certificate of registration before their bids will be considered.
- D. The Owner will consider, in determining the qualifications of a Bidder, his record in the performance of any contracts for construction work into which he may have entered with the Owner or with similar public or private bodies or corporations. The Owner expressly reserves the right to reject the bid of any Bidder if such record discloses that such Bidder, in the opinion of the Owner, has not properly performed such contracts or has habitually and without just cause neglected the payment of bills, or has otherwise disregarded his obligations, Subcontractors, material men, suppliers or employees.
- E. The Owner may make such investigation as they deem necessary to determine the ability of the Bidder to perform the work, and the Bidder shall furnish to the Owner all such information and data for this purpose as they may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of such Bidder, fails to satisfy the Owner that such Bidder is a responsive and responsible Bidder in accordance with N.C. Gen. Stat. 143-128 and 143-129, and the criteria set forth herein. Conditional bids will not be accepted.

A-5. BIDDER'S REPRESENTATIONS:

Each Bidder by submitting his Bid represents that:

- A. He has read and understands that Bidding Documents and his Bid is made in accordance therewith; and Bidder agrees to be bound by the terms and requirements set forth in the Bidding and Contract Documents;

- B. He has visited the site, has familiarized himself with the local conditions under which the Work is to be performed in accordance with Article A-9 herein, and has correlated his observations with the requirements of the proposed Contract Documents;
- C. His Bid is based upon the materials, systems and equipment required by the Bidding Documents without exception; and
- D. He has the capability, in all respects, and the moral and business integrity, reliability, technical ability, financial resources, plant, management, superintendence, equipment and materials which will assure effective and efficient good faith performance in full compliance with the Contract Documents and with any and all schedules and Milestone and Completion dates required by the Owner. The Bidder acknowledges and represents that he has made allowances for normal inclement weather indigenous to the Project Site, in his estimating, planning and scheduling of the Work. The Bidder hereby certifies that the work shall be completed, in place, in full accordance with the Contract Documents, within the time limits specified.
- E. He agrees that upon receipt of the Notice of Award, he will execute the formal Contract, and will deliver all bonds and proof of insurance coverage as required by the Specifications.
- F. He agrees to execute the formal Contract within ten (10) days from the date of Notice of Award, and in case he fails or neglects to appear within the specified time to execute the Contract, he will be considered as having abandoned the Contract, and the Bid Security accompanying this Proposal will be forfeited to the Owner by reason of such failure on the part of the Bidder.
- G. He has made a good faith effort to solicit Minority Business Enterprises (MBEs) per N.C. Gen. Stat. 143-128.2, as subcontractors. The Bidders shall provide the Owner a notarized affidavit with its bid stating that it made the good faith effort required pursuant to G.S. 143-128.2. The Bidder's failure to file the affidavit with its bid shall be grounds for rejection of the Bid.
- H. He has received the the General Conditions dated November 1, 2011.

A-6. BID SECURITY:

- A. Each bid must be accompanied by (1) cash; or (2) a Cashier's Check or a Certified Check of the Bidder in an amount not less than 5% of the bid, made payable to the Owner; or (3) a bidder's bond on the Bid Bond Form provided herein or on a similar form which in every respect materially complies with said Bid Bond, in the amount of 5% of his bid. For purposes of this provision, the amount of the bid shall be the Base Bid plus all positive amount alternates. The bidder's bond shall be issued by a surety company licensed to conduct business in North Carolina and acceptable to the Owner.
- B. Said bid security is given as a guarantee that the Bidder will enter into a contract if awarded the work and, in the case of refusal or failure to so enter into said contract, the security shall be declared forfeited to the Owner. Such security shall be returned to all but the three lowest Bidders within three days after the opening of bids and the remaining security will be returned within 48 hours after the Owner and the successful Bidder have executed the Contract. If no Contract has been awarded or the bidder has not been notified of the acceptance of his bid within forty-five (45) days of the bid opening, the Bidder may withdraw his bid and request the return of his bid security. If, at the Owner's or Construction Program Manager's request, the Bidder agrees to extend and maintain his bid beyond the specified 45 days, his bid security will not be returned until the expiration of the period of extension.

A-7. FORFEITURE OF BID BOND:

The Successful Bidder, upon his failure or refusal to execute the Contract within ten (10) days after he has received Notice of Award, shall forfeit to the Owner the security deposited with his bid in accordance with North Carolina General Statute 143-129.

A-8. MINORITY BUSINESS ENTERPRISES:

Contractor Responsibilities for Construction and Repair Projects Equal to or Greater Than Three Hundred Thousand Dollars (\$300,000).

- A. Each bidder, including first-tier subcontractors for construction manager at risk projects, shall identify on its bid the minority businesses that it will use on the project and an affidavit listing the good faith efforts it has made pursuant to N.C. Gen. Stat. § 143-128.2(f) and the total dollar value of the bid that will be performed by the minority businesses. A contractor, including a first-tier subcontractor on a construction manager at risk project, that performs all of the work under a contract with its own workforce may submit an affidavit to that effect in lieu of the affidavit otherwise required under this subsection.

The apparent lowest responsible, responsive bidder, within three business days, shall also provide either (1) an affidavit that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal or (2) documentation of its good faith effort that was identified in the bid to meet the goal, including any advertisements, solicitations, and evidence of other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract. *Failure to file the required affidavit or documentation that demonstrates that the contractor made the required good faith effort is grounds for rejection of the bid.*

- B. Bidder(s) on the Board's building projects shall undertake the following good faith efforts to recruit minority businesses to the extent required by N.C. Gen. Stat. § 143-128.2 and shall provide documentation to the Board that they have performed at least five (5) of these efforts:
1. Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor or available on State or local government maintained lists at least ten days before the bid or proposal date and notifying them of the nature and scope of the work to be performed.
 2. Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least ten days before the bid or proposals are due.
 3. Breaking down or combining elements of work into economically feasible units to facilitate minority participation.
 4. Working with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
 5. Attending any prebid meetings scheduled by the Board.
 6. Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors.

7. Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
 8. Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
 9. Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
 10. Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.
- C. Within 30 days after the award of the contract, the contractor shall provide to the school system's designated representative a list of all identified MBE subcontractors that the contractor will use on the project.
 - D. Failure to comply with procedural requirements as defined in the contract documents may render the bid as nonresponsive and may result in rejection of the bid and award to the next lowest responsible and responsive bidder.
 - E. During the construction of a project, if it becomes necessary to replace an MBE subcontractor, the prime contractor shall advise the owner. No MBE subcontractor may be replaced with a different subcontractor except (1) if the subcontractor's bid is later determined by the contractor or construction manager at risk to be nonresponsive or nonresponsive, or the listed subcontractor refuses to enter into a contract for the complete performance of the bid work or (2) with the approval of the Board for good cause. Good faith efforts as set forth in N.C. Gen. State. § 143-131(b) shall apply to the selection of a substitute subcontractor. Prior to substituting a subcontractor, the contractor shall identify the substitute subcontractor and inform the Board or its designee of its good faith efforts pursuant to N.C. Gen. State. § 143-131(b).
 - F. If during the construction of a project additional subcontracting opportunities become available, the prime contractor shall make a good faith effort to solicit subbids from MBEs.

A-9. SITE CONDITIONS AND CONDITIONS OF THE WORK:

- A. Each bidder must acquaint himself thoroughly as to the character and nature of the work to be done. Each bidder furthermore must make a careful examination of the site of the work and inform himself fully as to the difficulties to be encountered in the performance of the work, the facilities for delivering, storing and placing materials and equipment, and other conditions relating to construction and labor.
- B. No plea of ignorance of conditions that exist or may hereafter exist on the site of the work, or difficulties that may be encountered in the execution of the work, as a result of failure to make necessary investigations and examinations, will be accepted as an excuse for any failure or omission on the part of the successful Bidder to fulfill in every detail all the requirements of the Contract Documents and to complete the work or the consideration set forth therein, or as a basis for any claim whatsoever.

- C. Insofar as possible, the Successful Bidder, in carrying out his work, must employ such methods or means as will not cause interruption of or interference with the work of the Owner or any separate contractor.

A-10. BIDDER'S QUESTIONS, ADDENDA AND INTERPRETATIONS:

- A. Bidders and Sub-bidders shall promptly notify the Design Consultant of any ambiguity, inconsistency or error which they may discover upon examination of the Bidding and Contract Documents or of the site and local conditions. No interpretation of the meaning of the drawings, specifications or other contract documents will be made to any Bidder orally.
- B. Every request for such interpretation should be in writing addressed to the Design Consultant with a copy forwarded to the Owner.
- C. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the Bidding Documents which, if issued, will be transmitted to all prospective Bidders (at the respective addresses furnished for such purposes) not later than three calendar days prior to the date fixed for the opening of bids. Neither the Design Consultant nor the Owner will be responsible for any other explanations or interpretations of the proposed documents. Failure of any Bidder to receive any such addendum or interpretation shall not relieve any bidder from any obligation under his bid as submitted. All addenda so issued shall become part of the Contract Documents.
- D. Each Bidder shall ascertain prior to submitting his bid that he has received all Addenda issued, and he shall acknowledge receipt and inclusion in his proposal of all Addenda.

A-11. SECURITY FOR FAITHFUL PERFORMANCE:

The Successful bidder shall furnish a Performance Bond in an amount equal to one hundred percent (100%) of the Contract Sum as security for the faithful performance of this Contract and also a Labor and Material Payment Bond in an amount not less than one hundred percent (100%) of the Contract Sum, as security for the payment of all persons performing labor and furnishing materials under this Contract. The successful bidder shall provide a Performance Bond and a Labor and Material Payment Bond using the forms attached as Exhibits A and B. The Performance Bond and the Labor and Material Payment Bond shall be delivered to the Owner not later than the date of execution of the Contract.

A-12. TIME FOR COMPLETION AND LIQUIDATED DAMAGES FOR NON-COMPLETION:

The time for completion of this Contract and liquidated damages for non-completion within the stipulated time shall be as fixed in the Owner-Contractor Agreement, the General Conditions and the Supplementary Conditions.

A-13. LOCATION OF WORK:

The site of the proposed work is on Owner owned property, public streets, easements and/or other right-of-ways, as shown on the drawings.

A-14. LIABILITY INSURANCE AND WORKMEN'S COMPENSATION:

The Successful Bidder will be required to carry public liability and workmen's compensation and other insurance in the amounts and under the terms stipulated under the General Conditions.

A-15. BIDDERS REFERRED TO LAWS:

- A. The attention of Bidders is called to the provisions of all Municipal, County and State laws, regulations, ordinances and resolutions, as well as laws, regulations, ordinance resolutions and permits relating to obstructing streets, maintaining signals, storing and handling of explosives, or affecting the Bidder, or his employees or his work hereunder in his relation to the Owner or any other person. The Bidder shall obey all such laws, regulations, ordinances, permits or resolutions controlling or limiting Contractors while engaged in the prosecution of work under this Contract.
- B. The provisions of this contract shall be interpreted in accordance with the laws of North Carolina and in accordance with the laws, ordinances, regulations, permits and resolutions of Johnston County.

A-16. TAXES

All applicable Federal, State and Local Taxes shall be included in the Bidder's proposal. The successful bidder shall provide the Owner with documentation of North Carolina sales taxes paid for all purchases on the project in a form acceptable to the Owner.

A-17. RIGHT TO REJECT BIDS:

The Owner expressly reserves the right to reject any or all bids, to waive any informalities or irregularities in the bids received, and to accept that bid which in its judgment, best serves the interest of the Owner.

A-18. EQUAL PRODUCTS AND SUBSTITUTIONS:

- A. Whenever possible, the Design Consultant shall specify in the plans the required performance and design characteristics for materials as required by N.C. Gen. Stat. § 133-3. When it is impossible or impractical to specify the required performance and design characteristics for materials, the Design Consultant may use a certain brand, make, manufacturer, article, device, product, material, fixture, form or type construction by name, make or catalog number to convey the general style, type, character and standard of quality of the article desired. Unless specifically stated to the contrary, all materials, supplies and articles furnished under this Contract shall, whenever specified and otherwise practicable, be the standard products of recognized, reputable manufacturers. Unless otherwise specifically provided in the Contract Documents, the naming of a certain brand, make, manufacturer or article, device, product, material, fixture or type of construction shall convey the general style, type, character and standard of quality of the article desired and shall not be construed as limiting competition. If approval by the Design Consultant prior to bid opening is desired, the bidder shall request approval in writing at least ten (10) days prior to the bid date. The Design Consultant's approval will be in the form of an Addendum to the Specifications issued to all prospective Bidders indicating that the additional makes or brands are equivalent to those specified. Nothing in this paragraph is intended to restrict or inhibit free and open competition on school system projects.
- B. The bidder may request approval for substitutions of materials or type of construction in writing up to ten (10) days prior to the bid date. The standard for acceptance of substitutions shall be as expressed in Paragraph 4.15 of the contract General Conditions.

A-19. PREPARATION AND SUBMITTAL OF FORM OF BID:

- A. Bids shall be submitted utilizing the Form of Proposal as bound herein, or otherwise provided with the Contract Documents, and shall be complete in every respect. The total

bid amount shall be entered in words and figures in the space provided. Where applicable, the unit price or lump sum items, and their extensions, shall be entered in figures in the respective columns provided for each bid item. All entries shall be typewritten or printed in ink. The signatures of all persons shall be in longhand. Any entry of amount that appears on the face of the bid to have involved an erasure, deletion, white-out and/or substitution or other such change or alteration, shall show by them the initials of the person signing the bid and the date of the change or alteration. A failure to comply with this requirement may be cause for disqualification of the bid.

- B. For Unit Price bids, in the event of any discrepancies between the unit prices and the extensions thereof or the total bid amount, the unit prices shall govern. For Lump Sum bids, in the event of a discrepancy between the bid amount in writing and that in figures, the written value shall govern.
- C. Bids shall not contain any restatement or qualifications of work to be done, and alternate bids will not be considered unless called for. No oral bids or modifications will be considered.
- D. The amount of a bid submitted by a subcontractor to the general contractor under the single prime contracting system shall not exceed the bid, if any, for the same work by that subcontractor to the Owner under the multiple prime system.
- E. Each single-prime bid shall identify the contractors selected to perform the HVAC, plumbing and electrical work and the subcontractors' respective bid prices for the work

A-20. MODIFICATION OR WITHDRAWAL OF BID:

- A. A Bidder may withdraw his bid from consideration if such bid was based upon a mistake as provided in North Carolina General Statute 143-129.1.
- B. Prior to the time and date designated for receipt of bids, any bid submitted may be modified or withdrawn by notice to the party receiving bids at the place designated for receipt of bids. Such notice shall be in writing over the signature of the Bidder or by telegrams; if by telegram, written confirmation over the signature of the Bidder shall be mailed and postmarked on or before the date and time set for receipt of bids, and it shall be so worded as not to reveal the amount of the original bid.
- C. Withdrawn bids may be resubmitted up to the time designated for the receipt of Bids provided that they are then fully in conformance with this Information for Bidders.
- D. Bid security, if any is required, shall be in an amount sufficient for the bid as modified or resubmitted.

A-21. DETAILED BID BREAKDOWN:

If the Owner directs, the Bidder shall provide a detailed breakdown of his bid acceptable to the Owner. In addition to verifying accounting requirements, the breakdown may be used by the Owner to determine whether the Bidder has grossly misjudged the requirements of any area. Failure to provide the requested detailed breakdown may result in rejection of the bid proposal.

A-22. AWARD OF CONTRACT:

The contract will be awarded to the lowest responsive and responsible bidder under the single prime system or to the lowest responsive and responsible bidders under the

multiple prime system, taking into consideration quality, performance, and the time specified in the bids for the performance of the contract.

- A. The lowest multiple prime bidders and the lowest single prime bidder shall be determined by the aggregate amount of the unit prices set forth in the form of bid, if work is bid on a unit price basis, or the aggregate amount of the Base Bid, plus any Alternates selected by the Owner. Both multiple prime and single prime bids will be received and awarded according to state law.
- B. A Responsive Bidder shall mean a Bidder who has submitted a bid which conforms, in all material respects, to the Bidding Documents.
- C. A Responsible Bidder shall mean a Bidder who has the capability, in all respects, to perform fully the contract requirements and the moral and business integrity and reliability which will assure good faith performance. In determining responsibility, the following criteria will be considered:
 - 1. The ability, capacity and skill of the Bidder to perform the contract or provide the service required;
 - 2. Whether the bidder can perform the contract or provide the service promptly, or within the time specified, without delay or interference;
 - 3. The character, integrity, reputation, judgment, experience and efficiency of the Bidder;
 - 4. The quality of performance of previous contracts or services. For example the following information will be considered:
 - a. The administrative and consultant cost overruns incurred by Owners on previous contracts with Bidder,
 - b. The Bidder's compliance record with contract general conditions on other projects,
 - c. The submittal by the bidder of excessive and/or unsubstantiated extra cost proposals and claims on other projects,
 - d. The Bidder's record for completion of the work within the Contract Time or within Contract Milestones and Bidders compliance with scheduling and coordination requirements on other projects,
 - e. The Bidder's demonstrated cooperation with the Owner or the Design Consultant and other contractors on previous contracts,
 - f. Whether the work performed and materials furnished on previous contracts was in accordance with the Contract Documents;
 - 5. The previous and existing compliance by the bidder with laws and ordinances relating to contracts or services;
 - 6. The sufficiency of the financial resources and ability of the Bidder to perform the contract or provide the service;
 - 7. The quality, availability and adaptability of the goods or services to the particular use required;

8. The ability of the Bidder to provide future maintenance and service for the warranty period of the contract;
 9. Whether the Bidder is in arrears to the Owner on debt or contract or is a defaulter on surety to the Owner;
 10. Whether the bidder has demonstrated a good faith effort to use MBEs as subcontractors;
 11. Such other information as may be secured by the Owner having a bearing on the decision to award the contract, to include, but not limited to:
 - a. The ability, experience and commitment of the Bidder to properly and reasonably plan, schedule, coordinate and execute the Work,
 - b. Whether the Bidder has ever been debarred from bidding or found ineligible for bidding on any other projects.
- D. The purpose of the above is to enable the Owner in its opinion, to select the lowest responsible bidder. The ability of the low Bidder to provide the required bonds will not of itself demonstrate responsibility of the Bidder.
- E. The Owner reserves the right to require from the Bidder: (1) submissions of references, within seven days of bid opening, to include a listing of previous and current projects and (2) financial statements indicating current financial status, prepared in accordance with generally accepted accounting principles, by a CPA licensed to do business in North Carolina, and (3) any other information deemed necessary in order to establish the responsiveness and responsibility of the bidder.
- F. The Owner reserves the right to defer award of this contract for a period of forty-five (45) days after the due date of bids. During this period time, the Bidder shall guarantee the prices quoted in his bid.

Attachments:

- A. Performance Bond form
- B. Material and Labor Payment Bond form

END OF INFORMATION FOR BIDDERS

PERFORMANCE BOND

IT IS HEREBY AGREED that _____ (Insert full name and address of Contractor)

as Principal, hereinafter called Contractor, and, _____ (Insert full name and address of Surety)

as Surety, hereinafter called Surety, are held and firmly bound unto

Johnston County, by and through its authorized agent, the Johnston County Board of Education
Facilities and Construction
2320 US HWY 70 Business East,
Smithfield, NC 27577

as Oblige, hereinafter called Owner, in the amount of _____ Dollars (\$ _____), for the payment
whereof Contractor and Surety bind themselves, their heirs, executors, administrators, successors and
assigns, jointly and severally, firmly by these obligations.

WHEREAS, Contractor has by written agreement dated _____, 20____, entered into a
contract with Owner for the construction of _____ (Insert the name of the Project)

in accordance with Drawings and Specifications prepared by _____ (Insert full name and address of
Architect/Engineer)

which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if Contractor shall promptly
and faithfully perform said Contract, then this obligation shall be null and void; otherwise it shall remain in
full force and effect. The Surety hereby waives notice of any alteration or extension of time made by the
Owner.

Whenever Contractor shall be, and declared by Owner to be in default, under the Contract, the Owner
having performed Owner's obligations thereunder, the Surety may promptly remedy the default, or shall
promptly:

- 1) Complete the Contract in accordance with its terms and conditions, or
- 2) Obtain a bid or bids for completing the Contract in accordance with its terms and
conditions, and upon determination by Surety of the lowest responsible bidder, or, if the Owner
elects, upon determination by the Owner and the Surety jointly of the lowest responsible bidder,
arrange for a contract between such bidder and Owner, and make available as Work progresses
(even though there should be a default or a succession of defaults under the contract or contracts
of completion arranged under this paragraph) sufficient funds to pay the cost of completion less
the balance of the contract price; but not exceeding, including other costs and damages for which
the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term
"balance of the contract price," as used in this paragraph, shall mean the total amount payable by
Owner to Contractor under the Contract and any amendments thereto, less the amount properly
paid by Owner to Contractor.

Any suit under this bond must be instituted before the expiration of any applicable statute of repose under the Contract.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the Owner named herein or the heirs, executors, administrators or successors of the Owner.

Signed and sealed this _____ day of _____ 20____.

PRINCIPAL

[Affix corporate seal]

(Name)_____
(Title)_____

(Witness)

SURETY

[Affix corporate seal]

(Name)_____
(Title)_____

(Witness)

LABOR AND MATERIAL PAYMENT BOND

THIS BOND IS ISSUED SIMULTANEOUSLY WITH PERFORMANCE BOND IN FAVOR OF THE OWNER CONDITIONED ON THE FULL AND FAITHFUL PERFORMANCE OF THE CONTRACT

IT IS HEREBY AGREED that _____ (Insert full name and address of Contractor)

as Principal, hereinafter called "Principal," and, _____ (Insert full name and address of Surety)

as Surety, hereinafter called "Surety," are held and firmly bound unto

Johnston County, by and through its authorized agent, the Johnston County Board of Education
Facilities and Construction
2320 US HWY 70 Business East,
Smithfield, NC 27577

as Obligee, hereinafter called Owner, for the use and benefit of claimants as hereinbelow defined, in the amount of _____

_____ Dollars (\$ _____),
for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these obligations.

WHEREAS, Principal has by written agreement dated _____, 20_____, entered into a contract with Owner for the construction of the Clayton Middle School AHU 16 and 17 Replacement in accordance with Drawings and Specifications prepared by Dewberry Engineers, 2610 Wycliff Road, Suite 410, Raleigh, NC 27607

which contract is by reference made a part hereof, and is hereinafter referred to as the "Contract."

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if Principal shall promptly make payment to all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

1. A claimant is defined as one having a direct contract with the principal or with a Subcontractor of the Principal for labor, material, or both, used or reasonably required for use in the performance of the Contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

2. The above named Principal and Surety hereby jointly and severally agree with the Owner that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due claimant, and have execution thereon. The Owner shall not be liable for the payment of any costs or expenses of any such suit.

3. No suit or action shall be commenced hereunder by any claimant:

a) Unless claimant, other than one having a direct contract with the Principal, shall have given written notice to any two of the following: the Principal, the Owner, or the Surety above named, within ninety (90) days, after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail; postage prepaid, in an envelope addressed to the Principal, Owner or Surety, at any place where an office is

regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer.

b) After the expiration of one (1) year following the date on which Principal ceased Work on said Contract, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

c) Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the Project, or any part thereof, is situated, or in the United States District Court for the district in which the Project, or any part thereof, is situated, and not elsewhere.

4. The amount of this bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder, inclusive of the payment by Surety of mechanics' liens which may be filed of record against said improvement, whether or not claim for the amount of such lien be presented under and against this bond.

Signed and sealed this _____ day of _____ 20 ____.

PRINCIPAL

[Affix corporate seal]

(Name)_____
(Title)_____

(Witness)

SURETY

[Affix corporate seal]

(Name)_____
(Title)_____

(Witness)

BID FORM

Section 00 41 13.02

Contractor Initials & Date _____

Contract: **Mechanical/Electrical Construction**

Project: **Clayton Middle School AHU 16 & 17 Replacement**
Johnston County Public Schools Board of Education
Johnston County, NC

Bidder: _____

Date: _____

The undersigned, as bidder, hereby declares that the only person or persons interested in this proposal as principal or principals is or are named herein and that no other person than herein mentioned has any interest in this proposal or in the contract to be entered into; that this proposal is made without connection with any other person, company or parties making a bid or proposal; and that it is in all respects fair and in good faith without collusion or fraud.

The Bidder further declares that he has examined the site of the work and the contract documents relative thereto, has read all special and supplemental provisions furnished prior to the opening of bids, has satisfied himself relative to the work to be performed, and thereby proposes and agrees if this proposal is accepted, to furnish all necessary materials, equipment, machinery, tools, apparatus, means of transportation and labor necessary to complete the fabrication and delivery of the work, and other related work in full and complete accordance with the plans, specifications and contract documents, to the full and entire satisfaction of the Owner, with a definite understanding that no money will be allowed for extra work except as set forth in the General Conditions and other contract documents, on the **Clayton Middle School AHU 16 & 17 Replacement**.

Bidders are advised that a notice to proceed may be issued upon approval by the Johnston County Public Schools Board of Education, and in advance of the contract document.

The Bidder proposes and agrees, if this proposal is accepted, to execute a Contract within ten (10) days after notification of award, for the above work and for the below stated Compensation, in the form of Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum., for the sum of:

BASE BID: _____

_____ Dollars (\$ _____)

Mechanical Subcontractor:

_____ Sub Bid Amount (\$ _____)

Electrical Subcontractor:

_____ Sub Bid Amount (\$ _____)

Controls Subcontractor:

_____ Sub Bid Amount (\$ _____)

ALTERNATES:

The Bidder proposes to perform the work indicated as alternates for the amounts entered below, which amounts shall be added to or deducted from the Base Bid as indicated in the space below.

(Bidders must enter an amount for each alternate. If acceptance of the alternate will not change the contract amount, enter “No Change”. Insert the words “Add” or “Deduct” in the space provided before the amount.)

List of Alternates:	<u>Add/Deduct</u>	<u>Amount</u>
Alternate #1		
Manufacturer Preferred Brand BAS: Climatec (formerly ECS)	_____	\$ _____
Alternate #2		
Manufacturer Preferred Brand Fan: Loren Cook	_____	\$ _____
Alternate #3		
Manufacturer Preferred Brand VFD: ABB	_____	\$ _____

BID UNIT PRICES:

None.

BID ALLOWANCES:

Base bid shall include an allowance of \$5,000 to be used for unforeseen conditions as directed by JCPS. Unused allowance shall be returned to the owner at the end of the project.

ADDENDA:

The following addenda were received and used in computing this bid:

	<u>Date</u>	<u>Initial</u>
Addendum #1	_____	_____

The Bidder further proposes and agrees hereby to commence work under this contract on a date to be specified in a written order by the Owner or Designer on or before **August 01, 2025** and shall substantially complete the work on or before **180 calendar days** from the “Notice to Proceed” or the contract, whichever is dated first.

The undersigned further agrees that in the case of failure on his part to execute the said contract and the bond within ten (10) consecutive calendar days after written notice being given of the award of the contract, the certified check, cash or bid bond accompanying this bid shall be paid into the funds of the Owner’s account set aside for the project, as liquidated damages for such failure; otherwise the certified check, cash or bid bond accompanying this proposal shall be returned to the undersigned. Attach certified check, cash or bid bond to this proposal.

BID FORM

Section 00 41 13.02

Contractor Initials & Date _____

RESPECTFULLY SUBMITTED this _____ day of _____, 200 ____.

(Name of firm or corporation making bid)

By: _____

Title: _____
(Owner / Partner / President / Vice President)

License No. _____

Federal ID No. _____

WITNESS: (Proprietorship / Partnership)

By: _____

ATTEST: (Corporation)

By: _____

(CORPORATE SEAL)

Title: _____
(Corporate Secretary or Asst. Secretary Only)

BID BOND FORM Section 00 43 13

KNOW ALL MEN BY THESE PRESENTS, That we,

(Bidder's Name)

_____, of _____
(Street Address) (City, State, Zip)

Hereinafter called the Principal, and

(Surety's Name)

A corporation organized and existing under the Laws of the State of _____, and
authorized to transact business in the State of _____, as Surety, hereinafter
called Surety, are held and firmly bound unto the _____
(Owner).

Hereinafter called Obligee, in the Penal sum of five percent (5%) of the amount bid, good and lawful money
of the United States of America, for the payment of which the Principal and Surety bind themselves, their
heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

The Condition of this Obligation is such, that, WHEREAS the Principal has submitted a proposal to the
Obligee on a contract for the construction

of _____
(Contract Name and Number)

NOW THEREFORE, if the Obligee shall accept the bid of the Principal and the Principal shall enter into a
contract with the Obligee in accordance with the terms of such bid, and give such bond or bonds as may be
specified in the Bidding or Contract Documents with good and sufficient surety for the faithful performance
of such construction for the prompt payment of labor and material furnished in the prosecution thereof, or
in the event of the failure of the Principal to enter such contract and give such bond or bonds, if the Principal
shall pay to the Obligee the difference not to exceed the penalty hereof between the amount specified in
said bid and such larger amount for which the Obligee may in good faith contract with another party to
perform the Work covered by said bid, then this obligation shall be null and void; otherwise to remain in
full force and effect.

BID BOND FORM

Section 00 43 13

In witness whereof, we have hereunto set our signatures and seal this _____ day of _____, 20_____, all pursuant to due authorization.

Principal (Seal)

By
Surety

By
Attorney-in-Fact in accordance with the attached Power of Attorney

STATE OF _____)

ss:

COUNTY OF _____)

I, _____, a Notary Public in and for the State and County
aforesaid, do hereby certify that _____, and
_____, whose names are signed to the foregoing bond, this day
personally appeared before me in my State and County aforesaid and acknowledged the same.

Given under my hand seal this _____ day of _____, 19_____.

Notary Public (Seal)

My Commission expires:

Identification of HUB Certified/ Minority Business Participation

I, _____
(Name of Bidder)

do hereby certify that on this project, we will use the following HUB Certified/ minority business as construction subcontractors, vendors, suppliers or providers of professional services.

[illegible]

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

The total value of minority business contracting will be (\$)_____.

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of _____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- ☐ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ☐ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ☐ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ☐ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ☐ **5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- ☐ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ☐ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ☐ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ☐ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ☐ **10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

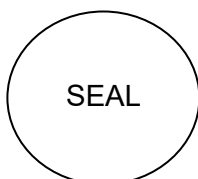
The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____
(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____
_____ contract.
(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

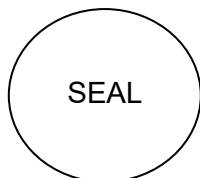
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.

This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

(Project Name)
Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____ % of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below.

Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

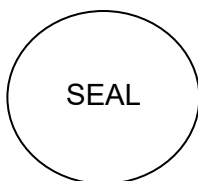
*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____



Signature: _____

Title: _____

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the _____
(Name of Bidder)

Project ID# _____ (Project Name) Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- Copies of quotes or responses received from each firm responding to the solicitation.
- A telephone log of follow-up calls to each firm sent a solicitation.
- For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.
- Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- Copy of pre-bid roster
- Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- Letter detailing reasons for rejection of minority business due to lack of qualification.
- Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

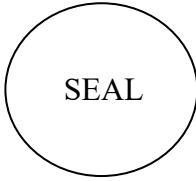
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

OWNER-CONTRACTOR AGREEMENT

THIS AGREEMENT is made this ____ day of _____ 2025 by and between the Johnston County Board of Education (herein referred to as the "Owner"), 2320 US HWY 70 Business East, Smithfield, NC 27577 and _____ (herein referred to as the "Contractor"), whose mailing address is _____. Correspondence, submittals, and notices relating to or required under this Agreement shall be sent in writing to the above addresses unless either party is notified in writing by the other of a change in address.

In consideration of the promises made herein and other good and valuable consideration, the following terms and conditions are hereby mutually agreed to, by and between the Owner and Contractor for the _____ Project.

The following documents, if any, are attached as Exhibits to this Contract and incorporated by reference herein.

Exhibit A- Scope of Work

Exhibit B - Sexual Offender Registry and Criminal Background Check Certification Form

1. **Scope of Services.** The project includes **Clayton Middle School Air Handling Unit 16 & 17 Replacement** more particularly described on Exhibit A. The Contractor shall perform the Work described on Exhibit A. The Work shall be performed in accordance with the terms of this Agreement and any plans and specifications referenced herein, all of which are incorporated into this Agreement. The Contractor shall provide all materials, tools, equipment, and labor, and supply all other services and things necessary to fully and properly perform and complete the Work as required by this Agreement. The Contractor shall perform the Work in compliance with all governmental laws and regulations. The Contractor shall also, unless otherwise specified, supply and pay for all transportation, utilities, fuel, sanitary facilities, and incidentals necessary for the completion of the Work, and be responsible for the safe, proper and lawful construction of the Work, and shall perform the Work in the best and most workmanlike manner, as shown on or stated in any plans or specifications referenced herein, or reasonably implied therefrom. All materials shall be new and of quality specified. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades, except as exceeded or qualified by any plans or specifications referenced herein. The Contractor shall keep the site and surrounding area reasonably free from rubbish at all times. Before final inspection and acceptance of the Work, the Contractor shall thoroughly clean the site, and completely prepare the Work and site for use by the Owner. The Contractor shall commence the Work promptly upon the date established in the Notice to Proceed and achieve Substantial and Final Completion by the dates established below.
2. **Representation of the Contractor.** In order to execute this Agreement and recognizing that the Owner is relying thereon, the Contractor, by executing this Agreement, makes the following express commitments to the Owner:
 - (A) The Contractor is fully qualified and licensed to act as the Contractor for the full scope of work for this Project and shall maintain any and all licenses, permits, insurance, and any authorizations necessary to act as the contractor.
 - (B) The Contractor has become familiar with the Project site and all conditions under which the Project is to be constructed and has identified to the Owner any and all issues.
 - (C) The Contractor has received and carefully reviewed all contract documents as listed above in Paragraph 1 and has found them complete, accurate, adequate, and sufficient for construction.
 - (D) The Contractor warrants title of all material, supplies, and equipment installed or incorporated into this Project and agrees upon completion of all work delivered to Owner free of any claims, liens, and charges.
3. **Compensation.** Provided that the Contractor shall strictly and completely perform all of its obligations under this Agreement, the Owner shall pay the Contractor \$_____. No compensation shall be paid for any additional work that is not approved in advance by the Owner. One progress payment per month, if any, may be made by the Owner to the Contractor only after certification that a portion of the Work is complete. Under no circumstances will the Owner make more than one payment per month. The Owner shall pay the Contractor within thirty (30) business days following approval of a payment request. Each payment request shall be signed by the Contractor and shall constitute the Contractor's surety that the quantity of work has reached the level for which payment is requested, that the work has been properly installed or performed in strict conformance with the requirements of this Agreement, and that the Contractor knows of no reason why payment should not be made as requested. The submission of a payment request also constitutes an affirmative representation and warranty that all work is free and clear of any lien, claim, or other encumbrance upon payment from the Owner. Final payment will be withheld until Contractor has provided Owner with copies of all Operation and Maintenance (O & M) Manuals and warranties applicable to the Work.

If requested by the Owner, the Contractor shall provide to the Owner a Schedule of Values for approval apportioning the Contract Price among the different elements of the Project for purposes of periodic and final payment within ten (10) calendar days of the date of commencement. The Schedule of Values shall be presented in enough detail to adequately apportion the contract to allow for breakdown of payments and shall include overhead and profit within each item. The Contractor's schedule of values shall not inflate any portion of the work. The Contractor acknowledges that the same documentation required for a Change in the Work shall be provided as backup for the use of allowances.

The amount of each payment request shall be computed as follows:

- (A) Take that portion of the Contract Sum properly allocable to completed Work as determined by multiplying the percentage completion of each portion of the Work by the share of the Contract Sum allocated to that portion of the Work in the schedule of values, less maximum retainage allowed by law. Pending final determination of cost to the Owner of changes in the Work, amounts not in dispute shall be included as amended;

- (B) add 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), less maximum retainage allowed by law;
- (C) subtract the aggregate of previous payments made by the Owner; and
- (D) subtract amounts, if any, for which the Owner has withheld or nullified a Certificate for Payment.

When payment is received from the Owner, the Contractor shall promptly pay all subcontractors, materialmen, laborers, and suppliers the amounts that are due for the work covered by such payment. In the event the Owner becomes informed that the Contractor has not paid these parties, the Owner has the right to issue future payments to the Contractor less the amounts owed to any subcontractor, supplier, or laborer. Continued claims for by subcontractors for lack of payment may be deemed a breach of this Agreement by the Contractor.

The Owner shall have the right to refuse to make payment and, if necessary, demand the return of a portion or all of the amount previously paid to the Contractor due to:

- (A) the quality of a portion, or all, of the contractor's work is not in accordance with the requirements of this contract;
- (B) the quantity of the Contractor's work not being as represented by the contractor's payment request;
- (C) the contractor's rate of progress being such that in the Owner's opinion, will not provide for final completion as required by this Contract;
- (D) the Contractor's failure to adequately keep records of as-built conditions; and
- (E) the Contractor's failure to use payments to pay project related obligation including but not limited to subcontractors, laborers, and material and equipment suppliers.

4. Substantial and Final Completion. When Substantial Completion has been achieved, the Contractor shall notify the Owner in writing that he/she is ready for a pre-final punchlist. At this time, the Contractor shall have already conducted its own internal punchlist of the completed work. The Owner and/or Design Consultant shall conduct an inspection of the completed and provide a written list of unfinished items or items in need of correcting. The Contractor shall bear the cost of any and all corrections of incomplete work, correcting and bringing into conformance all defective or nonconforming work. The Contractor shall notify the Owner when all nonconforming work has been completed and is ready for final inspection and subsequent final payment. If the Contractor feels it is outside of their control to finish the Work within the time prescribed, they must submit proper reasoning to the Owner in writing and at that time it is the Owner's discretion to accept or reject the request.

Prior to being entitled to receive final payment, the Contractor shall furnish the Owner:

- (A) an affidavit that all of the Contractor's obligations to subcontractors, laborers, equipment and material suppliers, or other third parties involved in the Project, have been paid or otherwise satisfied;
- (B) waiver of right of claim against the Surety bond; and
- (C) all product warranties, operating manuals, instruction manuals, record drawings, test results, and other documents expressly required to complete the Project.

5. Date of Commencement and Substantial Completion. The Contractor shall commence the performance of this Agreement on the date of this contract and diligently continue its performance until final completion. The contract time shall be measured from the date of commencement and the Contractor shall achieve Substantial Completion of the entire Work not later than _____. The Contractor shall achieve Final Completion within 15 days of date established above for Substantial Completion.
6. Changes in the Work. If the Owner elects to have a change in the Work performed on a lump sum or a time and material basis, the same shall be performed by the Contractor. The Contractor shall submit to the Owner complete documentation supporting the cost of the change in the Work in a format acceptable to the Owner. The Owner may require authentication of all time and material tickets and invoices prior to payment for the change in the Work. The failure of the Contractor to provide any required documentation shall constitute a waiver by the Contractor of any claim for the cost of that portion of the change in the Work. Up to 15% of direct material and labor costs can be applied as overhead and profit for the Contractor or any Subcontractor actually performing the work (said overhead and profit to include all small tools), and may further include the reasonably anticipated rental costs in connection with the Change in the Work, plus up to 8% thereof as overhead and profit. The Contractor and/or subcontractor may include up to 8% markup on any Change in the Work performed by a lower-tiered subcontractor. Payroll costs are limited to 39% of the net pay of the worker. Overhead and profit shall not be applied by the entity performing the work to labor burden, any sales and use tax paid for any purpose, or to any transportation or shipping costs incurred by the Contractor or any Subcontractor. Any change in the contract sum resulting from a Change Order shall be mutually agreed upon by the Contractor and the Owner together with any conditions relating thereto. If no mutual agreement can be reached between the Owner and the Contractor, the change in contract price, if any, shall be derived by the Owner determining reasonable actual costs incurred or saved.
7. Insurance. The Contractor shall obtain and maintain in effect during the term of this Agreement, general liability and automobile liability insurance in which the Owner and the Contractor shall each be named as insured parties in an amount not less than \$1,000,000, with a \$2,000,000 aggregate, for personal injury, including death, to any one person, and from claims for property damages in an amount of not less than \$1,000,000 for each occurrence arising from any act or omission of Contractor, its agents, employees or subcontractors. The Contractor shall obtain and maintain in effect during the term of this Agreement a policy or policies of workers' compensation insurance which shall cover all of Contractor's employees and all individuals who enter onto Owner's property on behalf of Contractor pursuant to this Agreement. The Contractor shall promptly furnish to the Owner certificates of insurance evidencing such insurance coverage.

Insurance required by this section shall contain an endorsement to provide the Owner at least 10-day's written notice of any intent to cancel or terminate by either the Contractor or insurance company. Contractor's Worker's Compensation policy shall contain an endorsement waiving subrogation against Owner. All such insurance policies shall be provided by insurance companies properly licensed in North Carolina and having a financial rating of at least "A" by A.M. Best or equivalent.

8. Hold Harmless. To the fullest extent allowed by law, the Contractor shall indemnify and hold the Owner harmless from and against any and all losses, liabilities, claims, lawsuits, judgments, and demands whatsoever, including costs of investigation (including reasonable legal fees and all costs) caused by any act or omission or intentional wrongdoing of the Contractor or its agents, employees or subcontractors. The parties agree that this indemnification clause is an "evidence of indebtedness" for purpose of N. C. Gen. Stat. § 6-21.2 and shall survive the termination, completion or expiration of this Agreement.
9. Codes, Permits, Applicable Laws and Owner's Policies. The Contractor shall at Contractor's expense obtain the required permits, give all notice and comply with all laws, ordinances, codes, rules, regulations and Owner's policies bearing on the conduct of the Work under this Agreement. If the Contractor observes that the drawings and specifications are at variance therewith, Contractor shall promptly notify the Owner in writing. If the Contractor performs any Work knowing (or under circumstances in which Contractor ought to have known) it to be contrary to such laws, ordinances, codes, rules and regulations. Contractor shall bear all cost arising therefrom. This Agreement and the relationship of the parties shall be construed under the laws of the state of North Carolina. Contractor shall not employ any individuals to provide services to the Owner who are not authorized by federal law to work in the United States. Contractor represents and warrants that it is aware of and in compliance with the Immigration Reform and Control Act and North Carolina law (Article 2 of Chapter 64 of the North Carolina General Statutes) requiring use of the E-Verify system for employers who employ twenty-five (25) or more employees and that it is and will remain in compliance with these laws at all times while providing services pursuant to this Agreement. Contractor certifies that as of the date of this Agreement, Contractor is not listed on the Final Divestment List created by the North Carolina State Treasurer pursuant to N.C. Gen. Stat. § 147-86.58. Contractor acknowledges that the Owner has adopted policies governing conduct on Owner's property and agrees to abide by any and all relevant Owner policies while on Owner's property. The Contractor acknowledges that Owner's policies are available on the Owner's website.
10. Safety Requirements. The Contractor shall be responsible for the Work area and the construction of the Work and provide all the necessary protections as required by laws, rules, regulations or ordinances governing such conditions and as required by the Owner. He shall be responsible for any damage Contractor or Contractor's employees, agents, suppliers or subcontractors cause to the Owner's property or that of others on the job and shall promptly repair any such damage. The Contractor shall clearly mark or post signs warning of hazards existing, and shall barricade excavations and similar hazards. Contractor shall maintain all necessary protective devices and signs throughout the progress of the Work.
11. Warranties. The Contractor guarantees and warrants to the Owner all Work as follows: that all materials and equipment furnished under this Agreement will be new and the best of its respective kind unless otherwise specified; that all Work will be of good quality in accordance with the industry standards; that the Work will be free of omissions and poor quality, defective material or workmanship; that the Work, including but not limited to, mechanical and electrical devices and equipment, shall be fit and fully usable for its intended and specified purpose and shall operate satisfactorily with ordinary care; that the products or materials incorporated in the Work will not contain asbestos; and that all subcontractors, agents or employees of Contractor will be fully qualified, possess any requisite licenses, and otherwise be legally entitled to perform the services provided. If, within one year (two years for painting) after the date of completion of the Work or designated portion thereof or within one year after acceptance by the Owner of designated equipment or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by this Agreement, any of the Work is found to be defective, not in accordance with this Agreement, or not in accordance with the guarantees and warranties specified in this Agreement, the Contractor shall correct it within five (5) working days or such other period as mutually agreed, after receipt of a written notice from the Owner to do so. For items which remain incomplete or uncorrected on the date of Substantial Completion, the one-year warranty shall begin on the date of Final Completion of the Work.
12. Termination for Convenience. The Owner may terminate this Agreement at any time in its complete discretion upon ten (10) days written notice. In the event of a termination for convenience, all finished or unfinished work and materials pursuant to this Agreement shall be turned over to the Owner and become its property. If the Agreement is terminated by the Owner in accordance with this section, the Owner shall only be responsible for paying Contractor for Work performed and accepted and materials delivered to the site as of the date of termination. In the event of a termination for convenience by Owner, Contractor's warranty shall still apply to all portions of the Work and all equipment installed by Contractor prior to termination.
13. Lunsford Act/Criminal Background Checks. Contractor acknowledges that G.S. § 14-208.18 prohibits anyone required to register as a sex offender under Article 27A of Chapter 14 of the General Statutes from knowingly being on the premises of any school. Contractor shall provide certification, on the form attached as Exhibit B, that it has conducted sexual offender registry checks and criminal background checks on each of its owners, employees, agents and subcontractors who will engage in any service on or delivery of goods to Owner's property (sex offender checks can be conducted at no cost at <http://www.nsopw.gov/>). Contractor shall not assign or allow any individual to deliver goods or provide services on Owner's property if said individual appears on any of the listed sex offender registries or who has ever had any of the following criminal convictions, or similar criminal convictions, without receiving prior written permission from Owner, which Owner may withhold in its reasonable discretion: murder, rape, sexual offense, sexual assault, statutory rape, indecent liberties with a minor, child abuse, kidnapping, abduction, manufacture, sale or delivery of controlled substances, assault with a deadly weapon, assault inflicting serious bodily injury, manslaughter, trafficking or exploitation of minors or felony level burglary, robbery, embezzlement, theft or larceny.

14. Anti-Nepotism. Contractor warrants that, to the best of its knowledge and in the exercise of due diligence, none of its corporate officers, directors, or trustees and none of its employees who will directly provide services under this Agreement are immediate family members of any member of the Owner's Board of Education or of any principal or central office staff administrator employed by such Board. For purposes of this provision, "immediate family" means spouse, parent, child, brother, sister, grandparent, or grandchild, and includes step, half, and in-law relationships. Should Contractor become aware of any family relationship covered by this provision or should such a family relationship arise at any time during the term of this Agreement, Contractor shall immediately disclose the family relationship in writing to the Superintendent of the Schools. Unless formally waived by the Owner, the existence of a family relationship covered by this Agreement is grounds for immediate termination by Owner without further financial liability to Contractor.
15. Entire Agreement. All of the representations and obligations of the parties are contained herein, and no modification, waiver or amendment of this Agreement or of any of its conditions or provisions shall be binding upon a party unless in writing signed by both parties. The waiver by any party of a breach of any provision of this Agreement shall not operate or be construed as a waiver of any subsequent breach of that provision by the same party, or of any other provision or condition of the Agreement. If any section, subsection, term or provision of this Agreement or the application thereof to any party or circumstance shall, to any extent, be invalid or unenforceable, the remainder of said section, subsection, term or provision of the Agreement or the application of the same to parties or circumstances other than those to which it was held invalid or unenforceable, shall not be affected thereby and each remaining section, subsection, term or provision of this Agreement shall be valid or enforceable to the fullest extent permitted by law.
16. Risk of Loss. Contractor shall bear the risk of loss in the event that any of the Work is stolen, lost damaged or destroyed prior to Final Completion of the Work and acceptance by Owner, unless caused by the intentional or reckless acts of Owner or Owner's authorized agents. If any of the Work is stolen, lost, damaged, or destroyed prior to Final Completion of the Work and acceptance by the Owner, due to any reason except the intentional or reckless acts of Owner or Owner's authorized agents, Contractor shall bear the full cost of repairing or replacing all such Work, including all equipment and materials.
17. Interpretation of Agreement. Contractor and Owner acknowledge that the Agreement shall not be construed against Owner due to the fact that it may have been drafted by Owner. For purposes of construing this Agreement, both Contractor and Owner shall be considered to have jointly drafted the Agreement.
18. Taxes. The Contractor shall pay all sales, consumer, use and other similar taxes for the Work or portions thereof provided by the Contractor which are legally enacted at the time bids are received, whether or not yet effective. The Contractor shall indemnify and hold the Owner harmless from any claims arising out of the Contractor's failure to pay all required taxes, including claims by the county for its inability to recover taxes that were not properly paid to the State of North Carolina by the Contractor.
19. Compliance with Solid Waste Disposal Act. In the event the Contract involves the purchase of more than \$10,000 in items designed by guidelines of the Environmental Protection Agency at 40 C.F.R. Part 247, Contractor agrees to comply with the requirements of section 6002 of the Solid Waste Disposal Act. In particular, the Contractor certifies that the percentage of recovered materials to be used in the performance of the Agreement will be at least the amount required by applicable specifications or other contractual requirements.
20. Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment. As detailed in 2 CFR § 200.216, Contractor certifies that any equipment, services, or systems provided through this Agreement shall not use covered telecommunications equipment or services as a substantial or essential component of a system or as part of any system.
21. Domestic Preference. As detailed in 2 CFR § 200.322, as appropriate and to the extent consistent with law, Contractor certifies that, to the greatest extent practicable, the goods, products, or materials furnished through this award will be produced in the United States (including but not limited to iron, aluminum, steel, cement, and other manufactured products).
22. Records Retention Requirements. The Contractor certifies that it will comply with the record retention requirements detailed in 2 CFR § 200.334. The Contractor further certifies that Contractor will retain all records as required by 2 CFR § 200.334 for a period of three years after grantees or subgrantees submit final expenditure reports or quarterly or annual financial reports, as applicable, and all other pending matters are closed.
23. Certification of Non-Collusion Statement. Contractor certifies under penalty of perjury that its response to this procurement solicitation is in all respects bona fide, fair, and made without collusion or fraud with any person, joint venture, partnership, corporation or other business or legal entity.
24. Prohibition on Gifts. Contractor certifies that it will comply with the prohibition against giving gifts, gratuities, favors or anything of monetary value to an officer, employee or agent of the School System. Contractor understands and agrees that violation of these standards will result in termination of the Agreement and may result in ineligibility for future contract awards.
25. Notice. All notices shall be in writing and shall be deemed submitted if mailed or emailed to the representatives as listed below at the respective addresses:

Owner's Representative/Address:
**2320 US HWY 70 Business East,
Smithfield, NC 27577**

Contractor's Representative/Address:

Neither the Owner's nor the Contractor's representative shall be changed without ten days written notice to the other party.

IN WITNESS WHEREOF, the Owner has caused this Agreement to be signed and the Contractor has caused this Agreement to be signed by a person with the authority to enter this Agreement, as hereinafter attested, all as of the day and year first above written.

**JOHNSTON COUNTY
BOARD OF EDUCATION**

[CONTRACTOR]

Superintendent

President/Vice President

This instrument has been preaudited in the manner required by the School Budget and Fiscal Control Act.

Finance Officer _____

Date _____

Exhibit A**Scope of Work**

Replacement of air handling unit 16 and 17 at Johnston County Public Schools Clayton Middle School as well as ancillary modifications to support replacement to meet project drawings and specifications.

Exhibit B

Sexual Offender Registry and Criminal Background Check Certification Form

Check the appropriate box to indicate the type of check:

- ☐ Initial
- ☐ Supplemental
- ☐ Annual

I, _____ (insert name), _____ (insert title) of _____ (insert company name) hereby certify that I have performed all of the required sexual offender registry and criminal background checks required under this Agreement for all contractual personnel (employees, agents, ownership personnel, or contractors) who may be used to deliver goods or provide services under this Agreement, including the North Carolina Sex Offender and Public Protection Registration Program, the North Carolina Sexually Violent Predator Registration Program, and the National Sex Offender Registry. I further certify that none of the individuals listed below appears on any of the above-named registries or has any criminal conviction listed in the Agreement, and that I will not assign any individual to deliver goods or perform services under this Agreement if said individual appears on any of the sex offender registries or has any criminal conviction listed in the Agreement, without the prior written permission of Owner . I agree to maintain all records and documents associated with these registry and criminal background checks, and that I will provide such records and documents to the Owner upon request. I specifically acknowledge that the Owner retains the right to audit these records to ensure compliance with this section at any time in the Owner's sole discretion. I acknowledge that I am required to perform these checks and provide this certification form before any work is performed under the Agreement (initial check), any time additional contractual personnel may perform work under the Agreement (supplemental check), and at each anniversary date of the Agreement (annual check).

Contractual Personnel Names

Job Title

1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

(attach additional page(s) if needed)

I attest that the forgoing information is true and accurate to the best of my knowledge.

(print name)
(title)

(signature)
(date)

Substitution Request Form Section 00 63 25

Date: _____

Clayton Middle School Air Handling Unit 16 & 17 Replacement

Architect: _____

Contractor: _____

CONTRACTOR'S REQUEST, WITH SUPPORTING DATA:

1. Section of the Specifications to which this request applies:

_____ Product data for proposed substitution is attached (description of product, reference standards, performance and test data).

_____ Sample is attached

_____ Sample will be sent if requested by Architect

2. Itemized comparison of proposed substitution with product specified.

	Original Product	Substitution
Name, Brand:	_____	_____
Catalog Number:	_____	_____
Manufacturer:	_____	_____
Significant Variations:	_____	

3. Unit costs of original product and proposed substitution

Original Product: \$ _____ per _____

Substitution: \$ _____ per _____

a) State whether cost is for: _____ Material Only or _____ Material Installed

Substitution Request Form Section 00 63 25

4. Proposed change in Contract Sum:

Credit to Owner: \$ _____

Additional Cost to Owner: \$ _____

5. Proposed Change in Contract Time:

Reduce/Increase Contract Time by _____ days.

6. Effect of the proposed substitution on other parts of the Work, or on other contracts: _____

7. Reason for requesting substitution: _____

Substitution Request Form Section 00 63 25

CONTRACTOR'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENTS:

We have investigated the proposed substitution and:

1. Believe that it is equal or superior in all respects to the originally specified product, except as stated in #2 above.
2. Shall provide the same warranty as required in General Conditions.
3. Shall provide the same special warranty or guaranty as specified.
4. Have included all cost data and cost implications of the proposed substitutions.
5. Shall pay review, redesign and special inspection costs caused by the use of this product.
6. Shall pay additional costs to other contractors caused by the substitution.
7. Shall coordinate the incorporation of the proposed substitution in the Work.
8. Shall modify other parts of the Work as may be needed to make all parts of the Work complete and functioning.
9. Waive future claims for added cost to Contractor caused by the proposed substitution.

Contractor (Signature): _____ Date: _____

ARCHITECT'S REVIEW AND ACTION:

_____ Rejected

_____ Provide more information in the following categories. Resubmit.

_____ Sign contractor's Statement of Conformance. Resubmit.

_____ The Proposed substitution is approved, with the following conditions:

The following changes will be made by Change Order number: _____

Addition/Deduction from the Contract Sum: \$ _____

Addition/Deduction from the Contract Time: _____ Days

Date

SECTION GC
GENERAL CONDITIONS
OF THE
CONTRACT FOR CONSTRUCTION

TABLE OF ARTICLES

1. CONTRACT DOCUMENTS
2. OWNER
3. CONTRACTOR
4. SUBCONTRACTORS
5. WORK BY OWNER OR BY SEPARATE CONTRACTORS
6. MISCELLANEOUS PROVISIONS
7. TIME
8. PAYMENTS AND COMPLETION
9. INSURANCE
10. CHANGES IN THE WORK
11. UNCOVERING AND CORRECTION
12. TERMINATION OF THE CONTRACT

ARTICLE 1

CONTRACT DOCUMENTS

1.1 GENERAL

- 1.1.1 The Contract Documents consist of the Owner-Contractor Agreement, the Conditions of the Contract (General, Supplementary and other Conditions), the Drawings, the Specifications, and all Addenda issued prior to and all 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 issued pursuant to the provisions of Article 10, (3) a written interpretation issued by the Design Consultant, or (4) a written order for a minor change in the Work issued pursuant to this contract.
- 1.1.2 By executing the Contract, the Contractor represents that he has visited the site, familiarized himself with the local conditions under which the Work is to be performed, and correlated his observations with the requirements of the Contract Documents.
- 1.1.4 The Contractor will be furnished with 3 sets of drawings and specifications at no cost. Additional copies may be purchased.

END OF ARTICLE 1

ARTICLE 2

OWNER

2.1 INFORMATION, SERVICES AND RIGHTS OF THE OWNER

- 2.1.1 The Owner shall at all times have access to the Work whenever it is in preparation or progress. The Contractor shall provide safe facilities for such access.
- 2.1.2 The Owner shall not be responsible for or have control or charge of the construction means, methods, techniques, sequences, or procedures, or for safety precautions and programs in connection with the Work, and will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.
- 2.1.3 The Owner will have authority to require special inspection or testing of the Work whether or not such Work is then fabricated, installed, or completed. However, neither the Owner's authority to act under Subparagraph 6.5.3, nor any decision made by the Owner in good faith either to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Owner to the Contractor, any Subcontractor, any of their agents or employees, or any other person performing any of the Work.
- 2.1.4 The Owner shall have the authority and discretion to call, schedule, and conduct job meetings to be attended by the Contractor, representatives of his Subcontractors, and the Design Consultant, to discuss such matters as procedures, progress, problems, and scheduling.
- 2.1.5 The Owner and Design Consultant shall not be responsible or liable to Contractor for the acts, errors or omission of the Contractor, any separate Subcontractor, any separate contractor or any contractor's or subcontractor's agents or employees, or any other persons performing any of the Work.
- 2.1.6 Information or services under the Owner's control shall be furnished by the Owner with reasonable promptness to avoid unreasonable delay in the orderly progress of the Work.
- 2.1.7 The parties acknowledge that the Owner may perform all or part of its obligations pursuant to this Agreement through the Superintendent or his designee.

2.1.8 The foregoing rights are in addition to other rights of the Owner enumerated herein and those provided by law.

2.2 OWNER'S RIGHT TO STOP OR TO SUSPEND THE WORK

2.2.1 If the Contractor fails to correct defective Work or fails to carry out the Work or supply labor and materials in accordance with the Contract Documents, the Owner by a written order may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the Owner to stop the Work shall not give rise to any duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity.

2.2.2 The Owner may order the Contractor in writing to suspend, delay, or interrupt all or any part of the Work for such period of time as he may determine to be appropriate for the convenience of the Owner.

2.2.3 If the performance of all or any part of the Work (including the work of the Contractor and its subcontractors) is, for an unreasonable period of time, suspended, delayed, or interrupted by an act of the Owner or the Design Consultant in the administration of this Contract, or by failure of any one of them to act within the time specified in this Contract (or if no time is specified, within a reasonable time), an adjustment shall be made for an increase in the actual time required for performance of the Work by the Contractor, due solely to such unreasonable suspension, delay, or interruption and the Contract modified in writing accordingly. However, no claim shall be made under this Subparagraph for any suspension, delay, or interruption pursuant to Subparagraph 2.3.1, or for which claim is provided or excluded under any other provision of this Contract. No claim under this Subparagraph shall be allowed on behalf of the Contractor or its subcontractors, unless within 10 days after the act or failure to act involved, and for continuing or ongoing acts or failures to act within 10 days of the first day of the act or failure to act the Contractor submits to the Owner a written statement setting forth, as fully as then practicable, the extent of such claim, and unless the claim is asserted in writing within 20 days after the termination of such suspension, delay, or interruption. For continuing or ongoing acts or failures to act, the Contractor shall update its written statement every 15 days until the suspension, delay or interruption is terminated. The Contractor shall waive any and all claims not filed in strict conformance with this paragraph. The Contractor shall indemnify, defend and hold the Owner harmless from any claim by a Subcontractor that is waived because it is not filed in strict conformance with this paragraph or any other provision of this Agreement regarding claims.

2.2.4 In the event of a suspension of work or delay or interruption of work, the Contractor will and will cause his subcontractors to protect carefully his, and their, materials and work against damage or injury from the weather and maintain completed and uncompleted portions of the work as required by the Contract Documents. If, in the opinion of the Owner, any work or material shall have been damaged or injured by reason of failure on the part of the Contractor or any of his subcontractors to so protect same, such work and materials shall be removed and replaced at the expense of the Contractor.

2.2.5 No claim by the Contractor shall be allowed if asserted after final payment under this Contract or if it is not asserted in strict conformance with Article 10.

2.3 OWNER'S RIGHT TO CARRY OUT THE WORK

2.3.1 If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within ten days after the date written notice is mailed by the Owner to commence and continue remedy of such default or neglect with diligence and promptness, the Owner may, without prejudice to any other remedy he may have, make good such deficiencies and may further elect to complete all Work thereafter through such means as the Owner may select, including the use of a new contractor. In such case the Owner shall issue a Change Order deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Design Consultant's additional services made necessary by such default, neglect or failure. Such action by the Owner and the amount charged to the Contractor are both subject to the prior approval of the Design Consultant. If the payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference to the Owner. Notwithstanding the Owner's right to carry out a portion of the work, warranty, maintenance and protection of the work remains the

Contractor's responsibility. Further, the provisions of this paragraph do not affect the Owner's right to require the correction of defective or non-conforming work in accordance with this contract.

END OF ARTICLE 2

ARTICLE 3

CONTRACTOR

3.1 DEFINITION

- 3.1.1 This entire Contract is not one of agency by the Contractor for Owner but one in which Contractor is engaged independently in the business of providing the services and performing the Work herein described as an independent contractor.

3.2 REVIEW OF CONTRACT DOCUMENTS

- 3.2.1 Before placing his proposal to the Owner, and continuously after execution of the Contract, the Contractor shall carefully study and compare the Contract Documents and shall at once report to the Owner any error, inconsistency or omission he may discover, including any requirement which may be contrary to any law, ordinance, rule, regulation or order of any public authority bearing on the performance of the Work. If the Contractor has reported in writing an error, inconsistency or omission, has promptly stopped the affected work until otherwise instructed, and has otherwise followed the instructions of the Owner, the Contractor shall not be liable to the Owner or the Design Consultant for any damage resulting solely from any such errors, inconsistencies or omissions in the Contract Documents. The Contractor shall perform no portion of the Work at any time without Contract Documents and, where required, approved Shop Drawings, Product Data or Samples for such portion of the Work.
- 3.2.2 All designs, drawings, specifications, design calculations, notes and other works provided for this contract are the sole property of the Owner and may not be used on any other design or construction project. The use of the design, including tracings and specifications, by any person or entity, for the purpose other than the Project, shall be at the full risk of such person or entity

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

- 3.3.1 The Contractor shall supervise and direct the Work, using his best skill and attention. He shall be solely responsible for and have control over all construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work and all statutory or legal requirements. This requirement applies continuously throughout contract performance and is not limited to regular working hours.
- 3.3.2 The Contractor shall be responsible to the Owner for the acts and omissions of his employees, Subcontractors and Sub- subcontractors, suppliers, their agents and employees, and other persons performing any of the Work and for their compliance with each and every requirement of the Contract Documents, in the same manner as if they were directly employed by the Contractor.
- 3.3.3 The Contractor shall not be relieved from his obligations to perform the Work in accordance with the Contract Documents either by the acts, failures to act or duties of the Owner or the Design Consultant in their administration of the Contract, or by inspections, tests or approvals (or the lack thereof) required or performed under Paragraph 6.5 by persons other than the Contractor.
- 3.3.4 The Contractor shall verify all grades, lines, levels and dimensions as indicated and shown on the Drawings and Specifications prior to beginning the work and shall immediately report in writing any errors or

inconsistencies to the Design Consultant before commencing the work.

- 3.3.5 Contractor shall protect existing surfaces, finishes and adjacent facilities from damage during construction. Any damage shall be repaired by Contractor at his own expense prior to completion of the Project. Prior to construction start, Contractor and Owner shall perform an inspection to record existing conditions, damaged and undamaged.

3.4 LABOR AND MATERIALS

- 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for all labor, materials, equipment, supplies, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary or proper for or incidental to the execution and completion of the Work required by and in accordance with the Contract Documents and any applicable code or statute, whether specifically required by the Contract Documents or whether their provision may reasonably be inferred as necessary to produce the intended results, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work. Final payment will not be made until the Work is so completed.
- 3.4.2 The Contractor shall at all times enforce strict discipline and good order among his employees and shall not employ on the Work any unfit person or anyone not skilled in the task assigned to him. The Owner may, by notice in writing, require the Contractor to remove from the work any employee the Owner deems incompetent, careless or otherwise objectionable. All agents and workers of the Contractor and its Subcontractors shall wear identification badges provided by the Contractor at all times they are on the Owner's property. The identification badges shall at a minimum display the company name, telephone number and employee's picture and name and must be worn in plain view at all times. Additionally, once school staff occupies the building, all contractors and their respective subcontractors shall be required to sign in and out of the visitor's log each day they are performing services. They must also wear a visitor's pass which will indicate to staff that they have met this requirement which applies to anyone performing services anywhere on the school property.
- 3.4.3 The Contractor shall be responsible for ensuring that the Work is completed in a skillful and workmanlike manner.
- 3.4.4 All equipment, apparatus and/or devices of any kind to be incorporated into the Work that are shown or indicated on the drawings or called for in the specifications or required for the completion of the work shall be entirely satisfactory to the Owner and the Design Consultant as regards operations, capacity and/or performance. No approval, either written or verbal, of any drawings, descriptive data or samples of such equipment, apparatus and/or device shall relieve the Contractor of his responsibility to turn over the same in good working order for its intended purpose at the completion of the Work in complete accordance with the Contract Documents. Any equipment, apparatus and/or device not fulfilling these requirements shall be removed and replaced by proper and acceptable equipment, etc. or put in good working order satisfactory to the Owner and Design Consultant without additional cost to the Owner.
- 3.4.5 All materials and Work shall meet North Carolina Building Codes. Should there be any discrepancies between design and code, the more stringent requirement shall apply. All materials shall comply with standards (or approved products) as set by the Specifications. Unless otherwise specified, NO ASBESTOS CONTAINING MATERIALS SHALL BE INSTALLED. BY DEFINITION, INSTALLATION OF ASBESTOS MATERIALS WILL BE CONSIDERED CONTRACTOR'S NEGLIGENCE AND THE CONTRACTOR SHALL PERFORM ALL NECESSARY WORK TO REMOVE THE ASBESTOS AND RESTORE THE SITE TO THE 'PRE-CONTRACT' CONDITION. Contractor shall assume all facilities built prior to 1979 have lead-based paint. Any paint removal shall be in accordance with OSHA standard pertaining to lead (29 CFR 1915.1025).
- #### 3.5 WARRANTY
- 3.5.1 The Contractor warrants to the Owner and the Design Consultant that all materials and equipment furnished under this Contract will be new unless otherwise specified, and that all workmanship will be of first class quality, free from faults and defects and in conformance with the Contract Documents and all other warranties and guaranties specified therein. Where no standard is specified for such workmanship or materials, they shall be

the best of their respective kinds. All Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. If required by the Owner or the Design Consultant, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. This warranty is not limited by the provisions of Article 11.

3.5.2 The warranties set forth in this Paragraph 3.5 and elsewhere in the Contract Documents shall survive Final Completion of the Work.

3.5.3 If, within one year after the Date of Substantial Completion of the Work or designated portion thereof or within one year after acceptance by the Owner of designated equipment or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be defective, not in accordance with the Contract Documents, or not in accordance with the guarantees and warranties specified in the Contract documents, the Contractor shall correct it within five (5) working days or such other period as mutually agreed, after receipt of a written 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 with reasonable promptness after discovery of the condition. For items, which remain incomplete or uncorrected on the date of Substantial Completion, the one-year warranty shall begin on the date of Final Completion of the Work. If the Contract Documents include painting work, the one year warranty period in this section shall be extended to two years.

3.5.4 If at any time deficiencies in the Work are discovered which are found to have resulted from fraud or misrepresentation, or an intent or attempt to or conspiracy to defraud the Owner by the Contractor, any Subcontractor or Supplier, the Contractor will be liable for replacement or correction of such Work and any damages which Owner has incurred related thereto, regardless of the time limit of any guarantee or warranty.

3.5.5 The Contractor shall bear the cost of making good all work of the Owner, separate contractors or others, destroyed or damaged by such correction or removal required under this Article 3, Article 11 or elsewhere in the Contract Documents.

3.6 TAXES

3.6.1 The Contractor shall pay all sales, consumer, use and other similar taxes for the Work or portions thereof provided by the Contractor which are legally enacted at the time bids are received, whether or not yet effective. The Contractor shall indemnify and hold the Owner harmless from any claims arising out of the Contractor's failure to pay all required taxes, including claims by the county for its inability to recover taxes that were not properly paid to the State of North Carolina by the Contractor.

3.6.2 The Contractor shall provide a completed Contractor's Sales Tax Report (attached hereto as Appendix A) with each application for payment for all items provided by the Contractor or any Sub-Contractors and incorporated into this project. The Contractor shall account for at least 2% of the total contract amount in sales tax or provide justification satisfactory to the Owner that the actual sales tax paid is less than 2%. In the event the Contractor does not provide adequate justification to support the shortfall, the Contractor shall pay the Owner the difference between the amount accounted for and the 2% minimum. Such compensation shall not be deemed a penalty, but reimbursement of funds the Owner would otherwise be entitled to recover from the State.

3.6.3 Sales and Use Tax. Contractor shall be responsible for complying with any applicable sales and use tax obligations imposed by Chapter 105, Article 5 of the North Carolina General Statutes. Where Contractor has been contracted with to oversee "new construction" or "reconstruction" as defined in G.S. 105-164.4H, Contractor shall be responsible for issuing and maintaining an Affidavit of Capital Improvement.

3.7 PERMITS, FEES AND NOTICES

3.7.1 The Contractor shall secure and pay for the building permit and for all other permits and governmental fees necessary for the proper execution and completion of the Work. Costs for service and final service connections by public utilities will be reimbursed to the Contractor by the Owner. The Owner shall not be responsible for the cost of any temporary utilities.

- 3.7.2 The Contractor will pay for his license and reinspection fees for the work necessary for the proper execution and completion of the work.
- 3.7.3 The Contractor shall give all notices and comply with all laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the Work.
- 3.8 PROGRESS SCHEDULE
- 3.8.1 The Contractor shall prepare and submit to the Owner for the Owner's review and approval an estimated progress schedule for the Work. This schedule shall be in accordance with any general requirements included in the Specifications for this project.
- 3.9 RESPONSIBILITY FOR COMPLETION
- 3.9.1 The Contractor shall furnish such manpower, materials, facilities and equipment and shall work such hours, including night shifts, overtime operations and Sundays and holidays, as may be necessary to ensure the performance of the Work within the Milestone and Completion dates specified in the Owner-Contractor Agreement.
- 3.9.2 If the actions taken by the Contractor are not satisfactory, the Design Consultant or Owner may direct the Contractor to take any and all actions necessary to ensure completion within the required Milestone and Completion dates, without additional cost to the Owner. In such event, the Contractor shall continue to assume responsibility for his performance and for completion within the required dates.
- 3.10 DOCUMENTS AND SAMPLES AT THE SITE
- 3.10.1 The Contractor shall maintain at the site for the Owner one record copy of all Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to record all changes made during construction, and approved Shop Drawings, Product Data and Samples. These shall be delivered to the Owner upon completion of the Work.
- 3.11 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES
- 3.11.1 The Contractor shall review, approve and submit, with reasonable promptness and in such sequence as to cause no delay in the Work or in the work of the Owner or any separate contractor, all Shop Drawings, Product Data, Manuals and Samples required by the Contract Documents.
- 3.11.2 Do not order materials until receipt of written approval. Furnish materials equal in every respect to approved samples.
- 3.11.3 By approving and submitting Shop Drawings, Product Data, Manuals and Samples, the Contractor represents that he has determined and verified all materials, field measurements, and field construction criteria related thereto, and that he has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents. The Contractor shall adhere to any supplementary processing and scheduling instructions pertaining to Shop Drawings, which may be issued by the Design Consultant.
- 3.11.4 The Contractor shall not be relieved of responsibility for any deviation from the requirements of the Contract Documents by the Design Consultant's review of Shop Drawings, Product Data, Samples or Manuals under unless the Contractor has specifically informed the Design Consultant in writing of such deviation at the time of submission and the Design Consultant has given written approval to the specific deviation. The Contractor shall not be relieved from responsibility for errors or omissions in the Shop Drawings, Product Data, Samples, or Manuals by the Design Consultant's review thereof.
- 3.11.5 The Contractor shall make corrections required by the Design Consultant and shall resubmit the required

number of corrected copies of Shop Drawings or new Product Data or Samples. The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data or Samples, to revisions other than those requested by the Design Consultant on previous submittals. Resubmittals necessitated by required corrections due to Contractor's errors or omissions shall not be cause for extension of Contract Time, and any costs associated with the processing of these resubmittals shall be paid by the Contractor.

- 3.11.6 No portion of the Work requiring submission of Shop Drawings, Product Data, Samples or Manuals shall be commenced until the submittal has been approved by the Design Consultant. All such portions of the Work shall be in accordance with approved submittals.

3.12 EQUAL PRODUCTS AND SUBSTITUTIONS

- 3.12.1 All materials, supplies and articles furnished under this Contract shall, whenever specified and otherwise practicable, be the standard products of recognized, reputable manufacturers. Unless otherwise specifically provided in the Contract Documents, the naming of a certain brand, make, manufacturer or article, device, product, material, fixture or type of construction shall convey the general style, type, character and standard of quality of the article desired and shall not be construed as limiting competition. The Contractor, in such cases, may with Design Consultant and Owner approval, use any brand, make, manufacturer, article, device, product, material, fixture, form or type of construction which in the judgment of the Design Consultant is equal to that specified. An item may be considered equal to the item so named or described if, in the opinion of the Owner and Design Consultant (1) it is at least equal in quality, durability, appearance, strength, and design; (2) it will perform at least equally the specific function imposed by the general design for the work being contracted for or the material being purchased; and (3) it conforms substantially, even with deviations, to the detailed requirements for the item in the specifications. Approval by the Owner and Design Consultant will be granted based upon considerations of quality, workmanship, economy of operation, suitability for the purpose intended, and acceptability for use on the Project.

- 3.12.2 Contractor must provide evidence that proposed substitution does not require revisions to the Contract Documents, that is consistent with Contract Documents, and will produce the indicated results, and is comparable with other portions of the Work. Contractor must provide a detailed comparison of significant qualities or proposed substitution with those of the Work specified, including but not limited to the following significant qualities: performance, weight, size, durability, visual effect, sustainable design features, warranties, and any specific features and requirements indicated in Contract Documents. An annotated copy of applicable Specification section and point-by-point comparison between specified product and the proposed substitution describing each point of compliance, non-compliance, and variance between the specified and proposed product shall be provided.

3.13 USE OF SITE

- 3.13.1 The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits, easements, right-of-way agreements and the Contract Documents. The Contractor shall not unreasonably encumber the site, in the opinion of the Owner, with any materials, equipment or trailers nor shall he block the entrances or otherwise prevent reasonable access to the site, other working and parking areas, completed portions of the Work and/or properties, storage areas, areas of other facilities that are adjacent to the worksite. If the Contractor fails or refuses to move said material, equipment or trailers within 24 hours of notification by the Owner, to so do, the Owner shall have the right, without further notice, to remove, at the Contractor's expense, any material, equipment and/or trailers which the Owner deems are in violation of this paragraph.

3.14 CUTTING AND PATCHING OF WORK

- 3.14.1 The Contractor shall not damage or endanger any portion of the Work or the work of the Owner or any separate contractors by cutting, patching or otherwise altering any work, or by excavation.
- 3.14.2 Existing structures and facilities including but not limited to building, utilities, topography, streets, curbs, walks, etc., that are damaged or removed due to required excavations or other construction work, shall be patched, repaired or replaced by the Contractor to satisfaction of the Design Consultant and the Owner of such structures

and facilities and authorities having jurisdiction.

3.15 CLEANING UP

- 3.15.1 The Contractor at all times shall keep the premises free from accumulation of waste materials or rubbish caused by his operations. If the Contractor fails to clean up during or at the completion of the Work, the Owner may do so and the cost thereof shall be charged to the Contractor.

3.16 INDEMNIFICATION

- 3.16.1 To the fullest extent permitted by law, the Contractor shall, at his sole cost and expense, indemnify, defend, and hold harmless the Owner and the Design Consultant and their agents, representatives, and employees from and against all claims, actions, judgments, costs, liabilities, penalties, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or caused by any negligent act, error, omission or breach of this Agreement by the Contractor, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable. The above obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity, which would otherwise exist as to any party or person, described in this Paragraph 3.16. The parties agree that this indemnification clause is an "evidence of indebtedness" for purpose of N.C. Gen. Stat. § 6-21.2. The parties also specifically acknowledge that the Owner is a public body and it is the intent of the parties that the Owner not incur any expenses when the Contractor is solely responsible for the claims. Contractor's indemnity obligations to Owner in the Contract Documents shall survive the expiration or termination of the Contract Documents.
- 3.16.2 In any and all claims against the Owner or the Design Consultant or any of their agents, representatives, or employees by any employee of the Contractor, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this Paragraph 3.16 shall not be limited in any way by Contractor's insurance coverage required herein.
- 3.16.3 No provision of this Paragraph 3.16 shall give rise to any duties on the part of the Design Consultant or the Owner, or any of their agents, representatives, or employees.

3.17 CONDITIONS AFFECTING THE WORK

- 3.17.1 The Contractor shall be responsible for taking all steps necessary to ascertain the nature and location of the Work and the general and local conditions, which can affect the Work or the cost thereof. The Owner assumes no responsibility for any understanding or representation about conditions affecting the Work made by any of his officers, employees, representatives, or agents prior to the execution of the Contract, unless such understandings or representations are expressly stated in the Contract Documents.

3.18 MISCELLANEOUS.

- 3.18.1 The Contractor shall provide documentation acceptable to the Owner showing the amount of MBE participation (including a complete list of all subcontractors and their final subcontract amounts) and sales tax paid by the Contractor and its subcontractors for materials purchased for Projects completed under this contract. The Contractor agrees to comply with the all of the Owner's policies at all times that the Contractor, its subcontractors and employees are on the Owner's property. The Contractor acknowledges that the Owner's policies can be accessed and viewed at the Owner's website. The Contractor shall comply with the Owner's site or school building access procedures when working on any existing school campus.

3.19 APPLICABLE LAWS.

- 3.19.1 This Contract and the relationship of the parties shall be governed by the laws of the state of North Carolina.
- 3.19.2 Contractor shall comply with all applicable laws and regulations in providing services under this Contract. Contractor shall not employ any individuals to provide services to the Owner who are not authorized by federal law to work in the United States. The Contractor represents that it is aware of and in compliance with the Immigration Reform and Control Act and North Carolina law (Article 2 of Chapter 64 of the North Carolina General Statutes) requiring use of the E-Verify system. The Contractor further warrants that it will use the E-Verify system to verify employment eligibility of all its employees throughout the term of this Contract, and that it will remain in compliance with all I-9 requirements throughout the term of this Contract. The Contractor

shall also ensure that any subcontractors use the E-Verify system at all times while providing subcontracted services in connection with this Contract. Contractor is responsible for providing affordable health care coverage to all of its full-time employees providing services to the school system. The definitions of “affordable coverage” and “full-time employee” are governed by the Affordable Care Act and accompanying IRS and Treasury Department regulations.

- 3.19.3 The Contractor also acknowledges that G.S. § 14-208.18 prohibits anyone required to register as a sex offender under Article 27A of Chapter 14 of the General Statutes from knowingly being on the premises of any school. The Contractor shall conduct or arrange to have conducted, at its own expense, sexual offender registry checks on each of its employees, agents, ownership personnel, or contractors (“contractual personnel”) who will engage in any service on or delivery of goods to school system property or at a school-system sponsored event, except checks shall not be required for individuals who are solely delivering or picking up equipment, materials, or supplies at: (1) the administrative office or loading dock of a school; (2) non-school sites; (3) schools closed for renovation prior to substantial completion; or (4) new school construction sites prior to substantial completion. The checks shall include at a minimum checks of the State Sex Offender and Public Protection Registration Program, the State Sexually Violent Predator Registration Program, and the National Sex Offender Registry (“the Registries”). For the Contractor’s convenience only, all of the required registry checks may be completed at no cost by accessing the United States Department of Justice Sex Offender Public Website at <http://www.nsopw.gov/>. The Contractor shall provide certification on the Sexual Offender Registry Check Certification Form (attached as Appendix C) that the registry checks were conducted on each of its contractual personnel providing services or delivering goods under this Agreement prior to the commencement of such services or the delivery of such goods. With each pay application, the Contractor shall provide an updated list of all Project subcontractors, identifying the date the subcontractor is anticipated to first be on the site, and the status of receipt of the Completed Sexual Offender Registry Check Certification Form from each subcontractor. The Contractor shall conduct a current initial check of the registries (a check done more than 30 days prior to the date of this Agreement shall not satisfy this contractual obligation). In addition, the Contractor agrees to conduct the registry checks and provide a supplemental certification form before any additional contractual personnel are used to deliver goods or provide services pursuant to this Agreement. The Contractor further agrees to conduct annual registry checks of all contractual personnel and provide annual certifications at each anniversary date of this Agreement. The Contractor shall not assign any individual to deliver goods or provide services pursuant to this Agreement if said individual appears on any of the listed registries. The Contractor agrees that it will maintain all records and documents necessary to demonstrate that it has conducted a thorough check of the registries as to each contractual personnel, and agrees to provide such records and documents to the Owner upon request. The Contractor specifically acknowledges that the Owner retains the right to audit these records to ensure compliance with this section at any time in the Owner’s sole discretion. Failure to comply with the terms of this provision shall be deemed a material breach of the Agreement. In addition, the Owner may conduct additional criminal records checks at the Owner’s expense. If the Owner exercises this right to conduct additional criminal records checks, the Contractor agrees to provide within seven (7) days of request the full name, date of birth, state of residency for the past ten years, and any additional information requested by the Owner for all contractual personnel who may deliver goods or perform services under this Agreement. The Contractor further agrees that it has an ongoing obligation to provide the Owner with the name of any new contractual personnel who may deliver goods or provide services under the Agreement. The Owner reserves the right to prohibit any contractual personnel of the Contractor from delivering goods or providing services under this Agreement if the Owner determines, in its sole discretion, that such contractual personnel may pose a threat to the safety or well-being of students, school personnel or others.
- 3.19.4 Anti-Nepotism. Contractor warrants that, to the best of its knowledge and in the exercise of due diligence, none of its corporate officers, directors, or trustees and none of its employees who will directly provide services under this Agreement are immediate family members of any member of the Board of Education or of any principal or central office staff administrator employed by the Board. For purposes of this provision, “immediate family” means spouse, parent, child, brother, sister, grandparent, or grandchild, and includes step, half, and in-law relationships. Should Contractor become aware of any family relationship covered by this provision or should such a family relationship arise at any time during the term of this Agreement, Contractor shall immediately disclose the family relationship in writing to the Superintendent of the Schools. Unless formally waived by the Board, the existence of a family relationship covered by this Agreement is grounds for immediate termination by Owner without further financial liability to Contractor.

3.19.5 Restricted Companies Lists. Provider represents that as of the date of this Contract, Provider is not included on the Final Divestment List created by the North Carolina State Treasurer pursuant to N.C. Gen. Stat. § 147-86.58. Provider also represents that as of the date of this Contract, Provider is not included on the list of restricted companies determined to be engaged in a boycott of Israel created by the North Carolina State Treasurer pursuant to N.C. Gen. Stat. § 147-86.81.

3.20 COMPLIANCE WITH BOARD POLICIES AND PROCEDURES

The Contractor acknowledges that Board policies are available for review at the Owner's website and agrees to comply with the policies. The Contractor also agrees to comply with the following provisions:

3.20.1 The Contractor, its Subcontractors and employees shall not possess or carry, whether openly or concealed, any gun, rifle, pistol, or explosive on any property owned by the Owner. This includes firearms locked in containers, vehicles or firearm racks within vehicles. The Contractor, its Subcontractors and employees shall not cause, encourage or aid a minor, who is less than 18 years old to possess or carry, whether openly or concealed, any weapons on any property owned by the Owner.

3.20.2 The Contractor, its Subcontractors and employees, are prohibited from profane, lewd, obscene or offensive conduct or language, including engaging in sexual harassment.

3.20.3 The Contractor and its Subcontractors shall not manufacture, transmit, conspire to transmit, possess, use or be under the influence of any alcoholic or other intoxicating beverage, narcotic drug, hallucinogenic drug, amphetamine, barbiturate, marijuana or anabolic steroids, or possess, use, transmit or conspire to transmit drug paraphernalia on any property owned by the Owner.

3.20.4 The Contractor and its Subcontractors may not at any time use or display tobacco or nicotine-containing products, including but not limited to electronic cigarettes (e-cigarettes), on school premises, both indoor and outdoor. The prohibition of the display of tobacco or nicotine products shall not extend to a display that has a legitimate instructional or pedagogical purpose. For purposes of this Contract, "tobacco product" is defined to include cigarettes, cigars, blunts, bidis, pipes, chewing tobacco, snuff, and any other items containing or reasonably resembling tobacco, tobacco products, or any facsimile thereof. "Tobacco use" includes smoking, chewing, dipping, or any other use of tobacco products.

3.20.5 The Contractor, its Subcontractors and employees shall not solicit from or sell to students or staff within the Owner's facilities or campuses, and shall not give gifts of any value to school system employees.

3.20.6 Operators of all commercial vehicles on any property owned by the Owner shall be subject to post-accident, random, reasonable suspicion and follow-up testing for drugs and alcohol.

3.20.7 The Contractor, its Subcontractors and employees are prohibited from using access to the site pursuant to this Agreement as a means to date, court, or enter into a romantic or sexual relationship with any student enrolled in the School System. The Contractor agrees to indemnify the Owner for claims against the Owner resulting from relationships which have occurred or may occur between a student and an employee of the Contractor or Subcontractor.

3.21 MINORITY AND HISTORICALLY UNDERUTILIZED BUSINESS

If the Contract Sum is \$300,000 or greater, the Contractor shall make a good faith effort to utilize minority and Historically Underutilized Businesses (HUBs) as defined and required in N.C. Gen. Stat. 143-128.2 to - 128.4. The Contractor shall identify in the list of its Subcontractors, those Subcontractors that are (HUBs) and indicate the portion of the Work that each Subcontractor will perform. If during the duration of the Project, the Contractor effects a substitution for any Subcontractor, or if additional subcontract opportunities become available, the Contractor shall make a good faith effort to utilize HUBs. The Contractor shall submit with each Application for Payment a list of those HUBs whose work is included in the application and the amount due each. Failure or refusal of the Contractor to submit the required information on HUBs shall be grounds to withhold payment.

END OF ARTICLE 3

ARTICLE 4

SUBCONTRACTORS

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

4.1.1 The Contractor, in compliance with the requirements of the Contract Documents, shall furnish in writing to the Owner the names of the persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each of the principal portions of the Work. The Owner will promptly reply to the Contractor in writing stating whether or not the Owner, after due investigation, has reasonable objection to any such proposed person or entity.

4.1.2. The Contractor shall identify in the list of names of the Subcontractors proposed, those Subcontractors that are Minority Business Enterprises and the date each is planned to begin work on the project. If during the duration of the project, the Contractor effects a substitution for any Subcontractor, or if additional subcontract opportunities become available, the Contractor shall make a good faith effort to utilize Minority Business Enterprises. At the completion of the project, the Contractor shall provide documentation acceptable to the Owner showing the amount of MBE participation (including a complete list of all subcontractors and their final subcontract amounts).

END OF ARTICLE 4

ARTICLE 5

WORK BY OWNER OR BY SEPARATE CONTRACTORS

5.1 OWNER'S RIGHT TO PERFORM WORK AND TO AWARD SEPARATE CONTRACTS

5.1.1 The Owner reserves the right to perform work related to the Project with his own forces, and to award separate contracts in connection with other portions of the Project or other work on the site under these or similar Conditions of the Contract.

5.2 MUTUAL RESPONSIBILITY

5.2.1 Should the Contractor cause damage to the work or property of the Owner or of any separate contractor on the Project, or to other work on the Site, or delay or interfere with the Owner's work on ongoing operations or facilities or adjacent facilities or said separate contractor's work, the Contractor shall be liable for the same; and, in the case of another contractor, the Contractor shall attempt to settle said claim with such other contractor prior to such other contractor's institution of litigation or other proceedings against the Contractor.

5.2.2 Should a separate contractor cause damage to the Work or to the property of the Contractor or cause delay or interference with the Contractor's performance of the Work, the Contractor shall present directly to said separate contractor any claims it may have as a result of such damage, delay or interference (with an information copy to the Owner) and shall attempt to settle its claim against said separate contractor prior to the institution of litigation or other proceedings against said separate contractor.

5.2.3. In no event shall the Contractor seek to recover from the Owner or the Design Consultant, and the Contractor hereby waives any claims against the Owner and Design Consultant relating to any costs, expenses (including, but not limited to, attorney's fees) or damages or other losses incurred by the Contractor as a result of any damage to the Work or property of the Contractor or any delay or interference caused by any separate

contractor.

5.3 COORDINATION OF THE WORK

- 5.3.1 By entering into this contract, Contractor acknowledges that there may be other contractors on the site whose work will be coordinated with that of his own. Contractor expressly warrants and guarantees that he will cooperate with other contractors and will do nothing to delay, hinder or interfere with the work of other separate contractors, the Owner or Design Consultant. Contractor also expressly agrees that, in the event his work is hindered, delayed, interfered with or otherwise affected by a separate contractor, his sole remedy will be a direct action against the separate contractor as described in this Article 5. Contractor will have no remedy, and hereby expressly waives any remedy, against the Owner and/or the Design Consultant on account of delay, hindrance, interference or other event caused by a separate contractor.

END OF ARTICLE 5

ARTICLE 6

MISCELLANEOUS PROVISIONS

6.1 GOVERNING LAW

- 6.1.1 This contract shall be governed by the law of the State of North Carolina. The Contractor and Owner agree that county where the Project is located shall be the proper venue for any litigation arising out of this Agreement.
- 6.1.2 Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein and the Contract shall be read and enforced as though it were included herein. If through mistake or otherwise, any such provision is not inserted or is not correctly or fully inserted, then upon the application of either party, the Contract shall forthwith be physically amended to make such insertion.

6.2 CLAIMS AND DAMAGES

- 6.2.1 Should the Contractor or any of its Subcontractors suffer injury or damage to person or property because of any act or omission of the Owner or Design Consultant, or of any of their employees, agents or others for whose acts either is legally liable, the claim on behalf of the Contractor or its subcontractors shall be made in writing to the Owner within 10 days after the first observance of such injury or damage; otherwise, the Contractor shall have waived any and all rights he may have against the Owner or the Design Consultant, or their employees, representatives and agents. The Contractor shall indemnify, defend and hold the Owner harmless from any claim by a Subcontractor that is waived because it is not filed in strict conformance with this paragraph or any other provision of this Agreement regarding claims.

6.4 RIGHTS AND REMEDIES

- 6.4.1 The duties and obligations of the Contractor imposed by the Contract Documents and the rights and remedies of the Owner available thereunder shall be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law.
- 6.4.2 Except as may be specifically agreed in writing, the failure of the Owner or the Design Consultant to insist in any one or more instances upon the strict performance of any one or more of the provisions of this Contract, or to exercise any right herein contained or provided by law, shall not be construed as a waiver or relinquishment of the performance of such provisions or right(s) or of the right to subsequently demand such strict performance or exercise such right(s), and the rights shall continue unchanged and remain in full force and effect.
- 6.4.3 The Contractor agrees that he can be adequately compensated by money damages for any breach of this

Contract which may be committed by the Owner and hereby agrees that no default, act, or omission of the Owner or the Design Consultant, except for failure to make progress payments as required by the Contract Documents, shall constitute a material breach of the Contract entitling the Contractor to cancel or rescind the provisions of this Contract or (unless the Owner shall so consent or direct in writing) to suspend or abandon performance of all or any part of the Work. The Contractor hereby waives any and all rights and remedies to which he might otherwise be or become entitled, save only his right to money damages.

6.4.4 Contractor and Owner acknowledge that the Contract Documents shall not be construed against Owner due to the fact that they may have been drafted by Owner. For purposes of construing the Contract Documents, both Contractor and Owner shall be considered to have jointly drafted the Contract Documents.

6.4.5 In the event that Owner incurs attorney's fees or litigation expenses in connection with enforcing or protecting its rights under the Contract Documents or defending any claim or lawsuit brought against it arising out of the Work or the Contract Documents, Contractor shall reimburse Owner for such reasonable attorney's fees and expenses.

6.5 TESTS

6.5.1 If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any portion of the Work to be inspected, tested, or approved, the Contractor shall give the Owner timely notice of its readiness so the Design Consultant and the Owner may observe such inspection, testing or approval. The Contractor shall bear all costs of such inspections, tests or approvals conducted by public authorities. Unless otherwise provided, the Owner shall bear all costs of other inspections, tests or approvals, except the Contractor shall be responsible for the cost of any reinspection, including the rescheduling of an inspection requested by the Contractor prior to proper the completion of the work to be inspection.

6.5.2 Unless otherwise stipulated in other Contract Documents, the Contractor shall pay for all utilities required for testing of installed equipment of all of his work and work of each Subcontractor. Boiler fuel other than gas shall be provided by Subcontractor furnishing boilers. Labor and supervision required for making such tests shall be provided at no additional cost to the Owner.

6.5.3 If the Design Consultant or the Owner determines that any Work requires special inspection, testing, or approval which Subparagraph 6.5.1 does not include, the Owner will instruct the Contractor to order such special inspection, testing or approval, and the Contractor shall give notice as provided in Subparagraph 6.5.1. If such special inspection or testing reveals a failure of the Work to comply (1) with the requirements of the Contract Documents, or (2) with respect to the performance of the Work, with laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction, the Contractor shall bear all costs thereof, including compensation for the Design Consultant's and Owner's additional construction management expenses made necessary by such failure.

6.6 UNENFORCEABILITY OF ANY PROVISION

6.6.1 If any provision of this Contract is held as a matter of law to be unenforceable or unconscionable, the remainder of the Contract shall be enforceable without such provision.

6.7 ATTORNEYS' FEES AND OTHER EXPENSES

6.7.1 The Contractor hereby agrees that he will not submit, assert, litigate or otherwise pursue any frivolous or unsubstantiated claims or claims he has specifically waived under the terms of the Contract Documents. In the event that the Contractor's or its Subcontractor's claims, or any separate item of a claim, is without substantial justification, the Contractor shall reimburse the Owner or Design Consultant for all costs and expenses associated with defending such claim or separate item, including but not limited to, attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, or services and any other consultant costs.

- 6.7.2 If the Contractor breaches any obligation under the Contract Documents, the Contractor shall reimburse the Owner and Design Consultant for all costs and expenses incurred by the Owner relating to such breach, including but not limited to attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, and any other consultant costs.
- 6.7.3 If the Owner or Design Consultant prevails in a claim brought against the Contractor, including but not limited to, claims for fraud or misrepresentation, overpayment, defective work, delay damages, and recovery of termination expenses, the Contractor shall reimburse the Owner and Design Consultant for all costs and expenses incurred by them relating to such claim, including but not limited to attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, and any other consultant costs.

END OF ARTICLE 6

ARTICLE 7

TIME

7.1 DEFINITIONS

- 7.1.1 Unless otherwise provided, the Contract Time is the period of time allotted in the Contract Documents for Substantial and Final Completion of the Work, as defined in Subparagraph 7.1.3 and 7.1.4, including any allowances and alternates. The Contractor shall complete his Work within Contract Time, unless the Contract Time is modified.
- 7.1.2 The date of commencement of the Work is the date established in a notice to proceed. If there is no notice to proceed, it shall be the date of the Owner-Contractor Agreement or such other date as may be established therein. The Contractor shall not commence Work or store materials or equipment on site until written Notice to Proceed is issued or until the Contractor otherwise receives the Owner's written consent.

7.2 DELAYS AND EXTENSIONS OF TIME

- 7.2.1 The time during which the Contractor or any of its subcontractors delayed in the performance of the Work by the acts or omissions of the Owner, Design Consultant or their employees or agents, acts of God, unusually severe and abnormal climatic conditions, fires, floods, epidemics, quarantine restrictions, strikes, riots, civil commotions or freight embargoes, or other conditions beyond the Contractor's or its subcontractors' control and which the Contractor or its subcontractors could not reasonably have foreseen and provided against, shall be added to the time for completion of the Work (i.e., the Contract Time) stated in the Owner-Contractor Agreement; provided, however, that no claim by the Contractor for an extension of time for delays will be considered unless made in strict compliance with the requirements of this Article and other provisions of the Contract Documents.
- 7.2.1.1 For excessive inclement weather, the Contract Time will not be extended due to reasonably anticipated inclement weather or for delays in the aftermath of inclement weather, reasonably anticipated or excessive. The time for performance of this Contract, as stated in the Contract Documents, includes an allowance for calendar days which may not be available for construction out-of-doors; for the purposes of this Contract, the Contractor agrees that the number of calendar days per month based on a five-year average shall be considered reasonably anticipated inclement weather and planned for in the construction schedule per the Contract. Unless the Contractor can substantiate to the satisfaction of the Owner that there was greater than the reasonably anticipated inclement weather considering the total cumulative time from the notice-to-proceed until the building is enclosed using data from the national weather service station identified in the supplemental conditions or a weather station acceptable to the Owner and that such alleged greater than reasonably anticipated inclement weather actually delayed the Work or portions thereof which had an effect upon the Contract Time, the Contractor shall not be entitled to an extension of time.

Also the Contractor agrees that the calculation of the number of excessive inclement weather days shall be the number of days in excess of the five-year average for each month, in which precipitation exceeded one tenth (.10) inch, or in which the highest temperature was 32 degrees F or less as recorded at the approved weather station. Rain days from hurricanes and tropical storms not causing damage in the county where the Project is located shall be deemed inclement weather days.

If the total accumulated number of calendar days lost to excessive inclement weather, from the notice-to-proceed until the building is enclosed, exceeds the total accumulated number to be reasonably anticipated for the same period based upon the five-year average, time for completion will be extended by the number of calendar days needed to include the excess number of calendar days lost. No extension of time will be made for days due to excessive inclement weather occurring after the building is enclosed or for contracts that do not include work out of doors that is not on the critical path. For the purpose of this Contract, the term "enclosed" is defined to mean when the building is sufficiently roofed and sealed, either temporarily or permanently, to permit the structure to be heated and the plastering and dry-wall trades to work. The Design Consultant shall determine when the structure is "enclosed". Upon the request of either party, the Design Consultant shall issue a letter certifying to the Owner, with a copy to the Contractor, stating the date the building became enclosed. No change in Contract Sum will be authorized because of adjustment of Contract time due to excessive inclement weather.

- 7.2.2 Should a time extension be granted for Substantial Completion the date for Final Completion shall be appropriately adjusted unless specifically stated otherwise.
- 7.2.3 Neither the Owner nor the Design Consultant shall be obligated or liable to the Contractor or its Subcontractors for, and the Contractor hereby expressly waives any claims against the Owner and the Design Consultant on account of any indirect or direct damages, costs or expenses of any nature which the Contractor, its Subcontractors, or Sub-subcontractors or any other person may incur as a result of any delays, interferences, changes in sequence or the like, which are reasonable, foreseeable, contemplated, or avoidable by Contractor, and it is understood and agreed that the Contractor's sole and exclusive remedy in any such events shall be an extension of the Contract Time in accordance with the Contract Documents, unless the delays, interferences, changes in sequence or the like arise solely from or out of any act or omission of the Owner or the Design Consultant, or their agents, employees, consultants or independent. The Contractor shall not be entitled to any damages or extensions of time pursuant to this section for concurrent delays for which the Contractor is at least partially responsible.
- 7.2.4 Subject to other provisions of the Contract Documents, the Contractor may be entitled to an extension of the Contract Time (but no increase in the Contract Sum) for delays arising from unforeseeable causes beyond the control and without the fault or negligence of the Contractor, his Subcontractors or suppliers, unless caused solely by the Owner or Design Consultant
- 7.2.5 The Contractor and its subcontractors shall not be entitled to and hereby expressly waives any extension of time resulting from any condition or cause unless said claim for extensions of time is made in writing to the Owner within ten (10) days of the first instance of delay.

END OF ARTICLE 7

ARTICLE 8

PAYMENTS AND COMPLETION

- 8.1 SCHEDULE OF VALUES
 - 8.1.1 Before the first Application for Payment, the Contractor shall submit to the Owner a schedule of values allocated to the various portions of the Work.
- 8.2 APPLICATIONS FOR PAYMENT

- 8.2.1 Prior to the date for each progress payment established in the Owner-Contractor Agreement, the Contractor, shall submit to the Owner an itemized Application for Payment including a completed Contractor's Sales Tax Report (attached hereto as Appendix A) for all items provided by the Contractor or any Subcontractors included in the application. The Contractor shall also certify that he has paid all due and payable amounts for which previous certificates for payment were issued and payments received from the Owner and that the work for which payment is requested has been completed.
- 8.2.2 The Owner will retain funds from each progress payment to the maximum extent allowed by N.C. General Statute 143-134.1 until the Work is finally completed and accepted, whether or not the Owner has occupied any or all of the Project before such time. If a reduction in retainage has been made or the Owner stops withholding retainage for any reason, the Owner may increase or commence the retainage as authorized by N.C. Gen. Stat. 143-134.1.
- 8.2.3 Owner will be under no obligation to make payment to the Contractor on account of materials or equipment not incorporated in the Work. Materials once paid for by the Owner become the property of the Owner and may not be removed from the work site without the Owner's written permission.
- 8.2.4 The Contractor warrants that title to all Work, materials and equipment covered by an Application for Payment will pass to the Owner either by incorporation in the construction or upon the receipt of payment by the Contractor, whichever occurs first, free and clear of all liens, claims, security interests or encumbrances, hereinafter referred to in this Article 8 as "liens".
- 8.2.5 All invoices shall show the following:
- .1 Total amount of contract
 - .2 Amount of change orders
 - .3 Total value of completed work
 - .4 Amount retained by Owner
 - .5 Amount due Contractor
- 8.3 CERTIFICATES FOR PAYMENT
- 8.3.1 By signing a Certificate for Payment, the Design Consultant shall not thereby be deemed to represent that it has made exhaustive or continuous on-site inspections to check the quality or quantity of the Work or that it has reviewed the construction means, methods, techniques, sequences, or procedures, or that it has made any examination to ascertain how or for what purpose the Contractor has used the moneys previously paid on account of the Contract Sum.
- 8.4 PROGRESS PAYMENTS
- 8.4.1 The Contractor shall promptly pay each Subcontractor (including suppliers, laborers, and material-men) performing labor or furnishing material for the Work, upon receipt of payment from the Owner.
- 8.4.2 No Certificate for a progress payment, nor any progress payment, nor any partial or entire use or occupancy of the Project by the Owner, shall constitute an acceptance of any Work not in accordance with the Contract Documents.
- 8.4.3 The Contractor shall not submit more than one pay application during any 30-day period.
- 8.5 PAYMENTS WITHHELD
- 8.5.1 The Design Consultant may decline to certify payment and may withhold their Certificate in whole or in part, to the extent the Design Consultant deems necessary to reasonably protect the Owner from loss associated with unsatisfactory job progress, defective construction, disputed work, claims or any other similar issue. The Design Consultant may also decline to certify payment if the Contractor fails to provide Subcontractor information regarding the use of HUBs and/or sexual registry checks. If the Design Consultant is unable to

make representations to the Owner and to certify payment in the amount of the Application, it will notify the Contractor as provided herein. The Design Consultant may also decline to certify payment because of subsequently discovered evidence or subsequent observations that may nullify the whole or any part of any Certificate for Payment previously issued to such extent as may be necessary in its opinion to protect the Owner from loss.

8.6 FAILURE OF PAYMENT

8.6.1 Payments due and unpaid under the Contract Documents shall not bear interest.

8.7 SUBSTANTIAL COMPLETION

8.7.1 The Date of Substantial Completion of the Work or designated portion thereof is the Date certified by the Design Consultant and Owner when the Work or a designated portion thereof is sufficiently complete, in accordance with the Contract Documents, so Owner can fully occupy and utilize the Work for the use for which it is intended, with all of the Project's parts and systems operable as required by the Contract Documents. Only incidental corrective work and any final cleaning beyond that needed for Owner's full use may remain for Final Completion. The Contractor shall be solely responsible for the cost to repair or replace any work damaged or destroyed prior to the Date of Substantial Completion.

8.7.2 When the Design Consultant and the Owner on the basis of an inspection jointly determine that the Work or designated portion thereof is substantially complete, they will then prepare a Certificate of Substantial Completion which shall establish the Date of Substantial Completion, shall state the responsibilities of the Owner and the Contractor for security, maintenance, heat, utilities, damage to the Work, and insurance, and shall fix the time within which the Contractor shall complete the items listed therein. 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. The Contractor shall provide operation & maintenance manuals, and operation training to the Owner as required by the Contract Documents prior to Substantial Completion. The Owner's occupancy of incomplete work shall not alter the Contractor's responsibilities pursuant to this section.

8.7.3 The acceptance of Substantial Completion payment shall constitute a waiver of all claims by the Contractor and its Subcontractors except those previously made in writing and identified by the Contractor as unsettled at the time the Contractor submits the Application for Payment for Substantial Completion, and except for the retainage sums due at final acceptance. The Contractor shall indemnify and hold the Owner harmless against any claims by its Subcontractors that are waived because they were not made in writing and identified by the Contractor as unsettled when the Contractor submitted the Application for Payment for Substantial Completion.

8.7.4 The issuance of the Certificate of Substantial Completion does not indicate final acceptance of the project by the Owner, and the Contractor is not relieved of any responsibility for the project except as specifically stated in the Certificate of Substantial Completion.

8.7.5 There will be two inspections by the Design Consultant at Substantial Completion:

- .1 To generate a list of items to be completed or corrected before Owner takes possession of the Work.
- .2 To check that the list of items has been completed before issuing Final Payment.

Any additional inspections by the Design Consultant requested by Contractor to complete the Punch List shall result in money being withheld from the Final Payment to cover the cost of these additional inspections.

8.8 FINAL COMPLETION AND FINAL PAYMENT

8.8.1 The date of Final Completion of the work is the date certified by the Design Consultant and the Owner when the Work is totally complete, to include punch list work, in accordance with the Contract Documents and the Owner may fully occupy and utilize the work for the use for which it is intended. The issuance of a temporary

or final certificate of occupancy shall not, in itself, constitute Final Completion.

8.8.1.1 When the Design Consultant and the Owner find the Work acceptable under the Contract Documents and the Contract fully performed, they will approve a final Certificate of Payment stating that to the best of their knowledge, information and belief, and on the basis of their observations and inspections, the Work has been completed in accordance with the terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor, and noted in said final Certificate, is due and payable, except for an amount mutually agreed upon for any work remaining incomplete or uncorrected for which the Owner is entitled a credit under the Contract Documents. If the Design Consultant and the Owner find the Work to be incomplete or unacceptable, the costs of re-inspections shall be paid by the Contractor.

8.8.2 Final Payment shall not become due until the Contractor provides to the Design Consultant and Owner: three (3) copies of any of the following required:

- .1 Final Change Order
- .2 Final Application for Payment
- .3 Consent of Surety to Final Payment - AIA G707(if applicable)
- .4 Contractor's Affidavit of Release of Liens - AIA G706A
- .5 Contractor's Affidavit of Payment of Debts and Claims - AIA G706;
- .6 Certificate of Occupancy (if applicable)
- .7 Contractor's Warranty, notarized
- .8 Warranty Summary Sheet with Original Warranties (if not included in O & M Manuals)
- .9 Certification Letter from Contractor that no Asbestos-Containing Materials were used on the project
- .10 Final List of Subcontractors (name, address, phone, email, fax nos.)
- .11 Record Drawings (As-Built) - 1 set
- .12 Operation and Maintenance Manuals - 3 sets
- .13 Other project close-out submittals, as required by the Contract Documents.

8.8.3 Neither the final payment nor the remaining retained percentage shall become due until the Work is free and clear of any and all liens and the Contractor submits to the Owner:

- .1 an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or his property might in any way be responsible, have been paid or otherwise satisfied;
- .2 if required by the Owner, other data establishing payment or satisfaction of all such obligations, such as receipts, releases and waivers of liens arising out of the Contract, to the extent and in such form as may be designated by the Owner; and
- .3 As-built drawings, and other project closeout submittals, as required by the Owner.

8.8.4 The making of final payment shall constitute a waiver of all claims by the Owner against the Contractor except those arising from:

- .1 unsettled liens, and claims against the Owner or the Design Consultant, or their employees, agents, or representatives,
- .2 faulty, defective or non-conforming Work discovered or appearing after Substantial or Final Completion,
- .3 failure of the Work to comply with the requirements of the Contract Documents,
- .4 terms of any warranties contained in or required by the Contract Documents,
- .5 damages incurred by the Owner resulting from lawsuits brought against the Owner, the Design Consultant, or their agents, employees or representatives because of failures or actions on the part of the Contractor, his Subcontractors, Sub-subcontractors, or any of their employees, agents or representatives, or

.6 fraud or bad faith committed by the Contractor or any subcontractor or supplier during performance of work but discovered by Owner after Final Payment.

8.8.5 The acceptance of final payment shall constitute a waiver of all claims by the Contractor except those previously made in writing and identified by the Contractor as unsettled at the time of the final Application for Payment

8.9 LIQUIDATED DAMAGES

8.9.1 ~~Should the Contractor fail to substantially complete the Work on or before the date stipulated for Substantial Completion (or such later date as may result from extension of time granted by Owner), he shall pay the Owner, as Substantial Completion liquidated damages the daily amount stated in the Supplementary Conditions for each consecutive calendar day that terms of the contract remain unfulfilled beyond the date allowed by the Contract, which sum is agreed upon as a reasonable and proper measure of damages which the Owner will sustain per day by failure of the Contractor to complete work within time as stipulated; it being recognized by the Owner and the Contractor that the injury to the Owner which could result from a failure of the Contractor to complete on schedule is uncertain and cannot be computed exactly. In no way shall costs for liquidated damages be construed as a penalty on the Contractor.~~

8.9.2 ~~For each consecutive calendar day that the Work remains incomplete after the date established for Final Completion, the Contractor shall pay or Owner will retain the daily amount stated in the Supplementary Conditions as Final Completion Liquidated Damages from the compensation otherwise to be paid to the Contractor. This amount is the minimum measure of damages the Owner will sustain due to the delay in the completion of all remedial work, the delay in the correction of the deficient work, the disruption to the school and the learning environment, the cost of contract management time and resources, administration time, and the inability to use the facilities fully. This amount is in addition to the liquidated damages prescribed above for Substantial Completion.~~

8.9.3 ~~The amount of liquidated damages set forth in the corresponding Supplementary Conditions shall be assessed cumulatively. The items of cost included in the assessment of liquidated damages are as defined above. This provision for liquidated damages does not bar Owner's right to enforce other rights and remedies against Contractor, including but not limited to, specific performance or injunctive relief.~~

8.10 OWNER'S RIGHT TO OCCUPY INCOMPLETE WORK

8.10.1 Should the Project, or any portion thereof, be incomplete for Substantial or Final Completion at the scheduled date or dates, the Owner shall have the right to occupy any portion of the Project. In such an event, the Contractor shall not be entitled to any extra compensation on account of said occupancy by the Owner or by the Owner's normal full use of the Project, nor shall the Contractor interfere in any way with said normal full use of the Project. Further, in such an event, the Contractor shall not be entitled to any extra compensation on account of the Owner's occupancy and use of the Project, nor shall the Contractor be relieved of any responsibilities of the Contract including the required times of completion and property insurance coverage, unless specifically altered by the Owner in writing. Such occupancy by the Owner shall not, in itself, constitute Substantial or Final Completion.

END OF ARTICLE 8

ARTICLE 9

INSURANCE AND BONDS

9.1 CONTRACTOR'S INSURANCE AND BONDS

The Contractor shall purchase and maintain in companies properly licensed by the Insurance Department of the State of North Carolina and acceptable to the Owner such insurance as will protect him, the Owner,

and the Owner's agents, representatives, and employees from claims which may arise out of or result from the Contractor's operations under the Contract, whether such operations be by himself or by any Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable. Such insurance shall include:

- 9.1.1 Worker's Compensation including Occupational Disease and Employer's Liability Insurance
- .1 Statutory - Amount and coverage as required by State of North Carolina Worker's Compensation laws
 - .2 Employer's Liability
\$1,000,000 Each Accident
\$1,000,000 Policy Limit
\$1,000,000 Each Employee
- 9.1.2 Commercial General Liability (Occurrence Form) - The Contractor shall provide during the life of this Contract such Commercial General Liability (Occurrence Form) Insurance as shall protect Contractor and any Subcontractor performing work under this Contract from claims for damages for Bodily Injury including accidental death, as well as from claims for Property Damage which may arise from operations under this Contract, whether such operations be by himself or by any Subcontractor or by anyone directly or indirectly employed by either of them. This insurance shall be on the Standard Insurance Services Office, Inc. (ISO) Commercial Liability Occurrence Form. The Contractor shall procure insurance coverage for direct operations, sublet work, elevators, **contractual liability** and completed operations with limits not less than those stated below:
- A Combined Single Limit for Bodily Injury, Property Damage and Personal Injury of:
- \$2,000,000 General Aggregate (except Products - Completed Operations) Limit
 - \$2,000,000 Products - Completed Operations Aggregate Limit
 - \$1,000,000 Personal and Advertising Injury Limit
 - \$1,000,000 Each Occurrence Limit
- 9.1.3 Property Damages, including Broad Form Property Damage and Explosion, Collapse, Underground property damage coverages, and blasting, where necessary.
- 9.1.4 Completed Operations Liability: Continuous coverage in force for one year after completion of Work.
- 9.1.5 Commercial Automobile Insurance, including coverage for owned, non-owned and hired vehicles - with limits not less than a Combined Single Limit for Bodily Injury and Property Damage of \$1,000,000.
- 9.1.6 Umbrella Liability Insurance: Policy to 'pay on behalf of the Insured' with Limits of Liability: \$1,000,000.
- 9.2 Certificates of Insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work. These Certificates shall contain a provision that coverages afforded under the policies will not be canceled until at least thirty (30) days prior written notice has been given to the Owner. Failure to provide such notice shall not limit the liability of the Insurer, its agents or representatives.
- 9.3 All insurance policies required in this Article, except Worker's Compensation and Commercial Automobile, shall name the Owner as additional named insured for the insurance.
- 9.4 Contractor shall not commence work under this Contract until he has obtained all the insurance and bonds required under Article 9 of this Contract and until such insurance and bonds have been approved by the Owner, nor shall Contractor allow any subcontractor to commence work on his subcontract until all similar insurance required of the subcontractor has been so obtained and approved. Approval of the insurance by Owner shall not relieve or decrease the liability of Contractor hereunder.
- 9.5 The Commercial General Liability and Workers Compensation Policies provided by Contractor shall have endorsements waiving subrogation against Owner.

- 9.6 PROPERTY INSURANCE. Contractor shall provide the following property insurance through at least Substantial Completion of the Project:
- 9.6.1 Unless stated otherwise in the Supplemental Conditions, Contractor shall purchase and at all times maintain such insurance as will protect Contractor, Owner, Subcontractors and Sub-subcontractors from loss or damage to Work or property in the course of construction, including all machinery, materials and supplies on the premises or in transit thereto and intended to become a part of the finished work until Final Completion. This insurance shall be in the form of 'Builder's Risk Covered Cause of Loss Form' to include, but not limited to, theft, collapse, earth movement and flood. Any deductible provision in such insurance shall not exceed \$5,000.00. Notwithstanding any such deductible provision, Contractor shall remain solely liable for the full amount of any item covered by such insurance.
- 9.6.2 If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion thereof, such occupancy or use shall not commence prior to a time mutually agreed to by Owner and Contractor, and to which the insurance company or companies providing the property insurance have consented by endorsement to the policy or policies. This insurance shall not be canceled or lapsed on account of such partial occupancy or use. Consent of Contractor and of the insurance company or companies to such occupancy or use shall not be unreasonably withheld.
- 9.7 Owner shall be under no obligation to review any Certificates of Insurance provided by Contractor, or to check or verify Contractor's compliance with any and all requirements regarding insurance imposed by the Contract Documents. Contractor is fully liable for the amounts and types of insurance required herein and is not excused should any policy or certificate of insurance provided by Contractor not comply with any and all requirements regarding insurance imposed by the Contract Documents.
- 9.8 All insurance companies providing the above insurance shall be licensed by the Insurance Department of the State of North Carolina and maintain a rating by AM Best or a similar rating company with a minimum of an "A-" rating.
- 9.9 PERFORMANCE AND PAYMENT BONDS
- "If required by law, or in the Supplemental Conditions or the Contract Documents, Contractor must provide performance and payment bonds each in the amount of the Contract Sum. Such bonds shall be on forms acceptable to Owner and issued by surety companies licensed to do business in North Carolina and having a rating of at least AM Best "A" rating. Contractor may, at its option, make deposit in the form of certified check with Owner in lieu of the performance and payment bonds in an amount equal to the Contract Sum for each such bond, for a total of 200% of the Contract Sum."
- 9.10 Risk of Loss: Contractor shall bear the risk of loss in the event that any of the Work is stolen, lost, damaged or destroyed prior to the Final Completion of the Work, the issuance of a final Certificate of Occupancy, and acceptance of the Work by the Owner. If any of the Work is stolen, lost, damaged, or destroyed prior to Final Completion, the issuance of a final Certificate of Occupancy, and acceptance of the Work by the Owner, due to any reason except the intentional or reckless acts of Owner or Owner's authorized agents, Contractor shall bear the full cost of repairing or replacing all such Work, including all equipment and materials. Contractor should purchase his own insurance to cover this risk if required by the Contract Documents or otherwise if the Contractor so chooses.

END OF ARTICLE 9

ARTICLE 10

CHANGES IN THE WORK

10.1 CHANGE ORDERS/CONSTRUCTION CHANGE DIRECTIVE

- 10.1.1 The Owner may, at any time, by written order designated or indicated to be a Change Order, make any change or modification in the Work or add to the Work within the general scope of the Contract.
- 10.1.2 A Change Order is a document executed pursuant to this Article when the Owner and Contractor agree to Changes in the Work, the Contract Sum, the Contract Time and any other change in the Contract by written agreement signed by Owner, Contractor and Design Consultant designated or indicated to be a Change Order. If the Contractor, subsequent to the issuance of a Construction Change Directive, agrees to its terms including any applicable adjustment to the Contract Sum and Contract Time, Contractor shall sign it and it shall become a Change Order.
- 10.1.3 A Construction Change Directive is a written order prepared by the Design Consultant and signed by the Owner and Design Consultant, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both.

10.2 OWNER DIRECTED CHANGES REQUIRING AN INCREASE IN CONTRACT SUM.

- 10.2.1 If the Change in the Work will result in an increase in the Contract Sum, the Owner shall have the right to require the performance thereof on a lump sum basis, a unit price basis or a time and material basis, all as hereinafter more particularly described (the right of the Owner as aforesaid shall apply with respect to each such Change in the Work).

If the Owner elects to have the Change in the Work performed on a lump sum basis, its election shall be based on a lump sum Proposal which shall be submitted by the Contractor to the Owner within seven (7) days of the Contractor's receipt of a request therefore (but the Owner's request for a lump sum Proposal shall not be deemed an election by the Owner to have the Change in the Work performed on a lump sum basis). The Contractor's Proposal shall be itemized and segregated by labor and materials for the various components of the Change in the Work (no aggregate labor or material total will be acceptable) and shall be accompanied by signed Proposals of any Subcontractors who will perform any portion of the Change in the Work and of any persons who will furnish materials or equipment for incorporation therein. The Proposal shall also include the Contractor's estimate of the time required to perform said changes. The Contractor shall provide any documentation that may be requested by the Owner or Design Consultant to support the change proposal, including but not limited to payroll records, insurance rates, material quotes, and rental quotes. The Change Proposal Forms attached as Appendix B shall be used to submit change proposals on the Project.

The portion of the Proposal relating to labor, whether by the Contractor's forces or the forces of any of its Subcontractors, may include reasonably anticipated gross wages of job site labor, including foremen, who will be directly involved in the Change in the Work (for such time as they will be so involved), plus payroll costs (including premium costs of overtime time, if overtime is anticipated, Social Security, Federal or State unemployment insurance taxes and fringe benefits required by collective bargaining agreements entered into by the Contractor or any such Subcontractor in connection with such labor) and up to fifteen percent (15%) of such anticipated gross wages, but not payroll costs, as overhead and profit for the Contractor or any such Subcontractor, as applicable (said overhead and profit to include all supervision except foremen). Payroll costs are limited to 39% of the net pay of the worker.

The portion of the Proposal relating to materials may include the reasonably anticipated direct costs to the Contractor or to any of its Subcontractors of materials to be purchased for incorporation in the Change in the Work, plus transportation and applicable sales and use taxes and up to fifteen percent (15%) of said direct material costs as overhead and profit for the Contractor or any such Subcontractor (said overhead and profit to include all small tools), and may further include the Contractor's and any of its Subcontractor's reasonably anticipated rental costs in connection with the Change in the Work (either actual or discounted local published

rates), plus up to eight percent (8%) thereof as overhead and profit for the Contractor or any such Subcontractors, as applicable. The Contractor shall provide an itemized breakdown of all transportation and shipping costs, including receipts documenting the expenses. Notwithstanding the above, overhead and profit shall not be applied to any sales tax paid for any purpose or to any transportation or shipping costs incurred by the Contractor or any subcontractor. If any of the items included in the lump sum Proposal are covered by unit prices contained in the Contract Documents, the Owner may, if it requires the Change in the Work to be performed on a lump sum basis, elect to use these unit prices in lieu of the similar items included in the lump sum Proposal, in which event an appropriate deduction will be made in the lump sum amount prior to the application of any allowed overhead and profit percentages. No overhead and profit shall be applied to any unit prices.

The lump sum Proposal may include up to eight percent (8%) of the amount which the Contractor will pay to any of its Subcontractors for Changes in the Work as overhead and profit for the Contractor. The Contractor shall not be reimbursed for the costs of the Subcontractors' Payment and Performance Bonds, as such bonding is not required by the Owner.

- 10.2.2 In the event that (1) the parties are unable to agree as to the reasonable cost and time to perform the Change in the Work based upon the Contractor's Proposal and the Owner does not elect to have the Change in the Work performed on a time and material basis, (2) the Contractor fails to submit his Proposal within the designated period, or (3) the Work needs to begin immediately, the Owner may choose to make a determination of the reasonable cost and time to perform the Change in the Work, based upon its own estimates, the Contractor's submission or a combination thereof. A Construction Change Directive shall be issued in this case for the amounts of cost and time determined by the Owner and shall become final and binding upon the Contractor, subject to Contractor's right to dispute such action in accordance with Paragraph 10.9. Owner has the right to direct by Construction Change Directive a Change in the Work, which is the subject of such Change Order. Failure of the parties to reach agreement regarding the cost and time of the performing the Construction Change Directive, shall not relieve the Contractor from performing the Change in the Work promptly and expeditiously.
- 10.2.2.1 The Owner reserves the right to reject the Contractor's Proposal for a Change in the Work and to elect to perform said Work using a Separate Contractor. Under such circumstances, all provisions of Article 6 shall be in force.
- 10.2.3 If the Owner elects to have the Change in the Work performed on a time and material basis or on a time and material basis with a not to exceed amount, the same shall be performed, whether by the Contractor's forces or the forces of any of its Subcontractors or Sub-subcontractors, at actual cost to the entity performing the Change in the Work (without any charge for administration, clerical expense, supervision or superintendence of any nature whatsoever, including foremen, or the cost, use or rental of tools or plant), plus fifteen percent (15%) thereof as the total overhead and profit (except that said fifteen percent (15%) shall not be applied against any payroll costs, as set forth in Paragraph 10.2.1.). If the Owner and Contractor agree upon a not to exceed amount, it shall be clearly identified in the Change Order or change proposal form and shall be the maximum amount paid by the Owner for the identified work. The Contractor shall submit to the Owner daily time and material tickets, on a daily basis to include the identification number assigned to the Change in the Work, the location and description of the Change in the Work, the classification of labor employed (and names and social security numbers), the materials used, the equipment rented (not tools) and such other evidence of cost as the Owner may require. The Owner may require authentication of all time and material tickets and invoices by persons designated by the Owner for such purpose. The failure of the Contractor to secure any required authentication shall, if the Owner elects to treat it as such, constitute a waiver by the Contractor of any Claim for the cost of that portion of the Change in the Work covered by a non-authenticated ticket or invoice; provided, however, that the authentication of any such ticket or invoice by the Owner shall not constitute an acknowledgment by the Owner that the items thereon were reasonably required for the Change in the Work.
- 10.2.3.1 The Contractor may only bill for all or a portion of work performed on a time and material basis if the work has been completed, accepted and properly documented to the Owner and Design Consultant's satisfaction.
- 10.2.4 No overhead and profit will be paid by the Owner on account of a Change in the Work except as specifically

provided in Section 10.2. Overhead and profit, as allowed under Section 10.2, shall be deemed to include all costs and expenses which the Contractor or any of its Subcontractors may incur in the performance of a Change in the Work and which are not otherwise specifically recoverable by them pursuant to Section 10.2.

10.3 CONTRACTOR NOTICE OF CHANGE

- 10.3.1 If the Contractor or any of its Subcontractors asserts that any event or occurrence has caused a change in or addition to the Work which change causes an increase or decrease in the Contractor's or its Subcontractors' cost or the time required for the performance of any part of the Work under the Contract, including Work not affected directly by the change, the Contractor shall, within ten (10) days of such event, give the Owner written notice as herein required. Said notice shall include the instructions or circumstances that are the basis of the claim and the Contractor's best estimate of the cost and time involved.
- 10.3.2 If the Contractor intends to assert a claim under this Article, he must, within ten (10) days after receipt of a written Change Directive under Subparagraph 10.2.1 above or the furnishing of a written notice under Subparagraph 10.3.1, submit to the Owner a written statement setting forth the specific nature and cost of such claim, unless this period is extended by the Owner. The statement of claim hereunder may be included in the notice under Subparagraph 10.3.1 above. The statement of claim shall include all direct, indirect and impact costs associated with the change, as well as the Contractor's estimate of the schedule impact of the change, if any. The Contractor and its subcontractors shall not be entitled to reimbursement for any claims that are not filed in strict conformance with this Article. The Contractor shall indemnify and hold the Owner harmless against any claims by Subcontractors that are waived because they are not filed in strict conformance with this Article.
- 10.3.3 If the parties are unable to agree to the reasonable cost and time to perform the Change, or are unable to agree as to whether a change occurred, the Owner shall make a unilateral determination as described in Article 10.2.2. The Contractor shall proceed pursuant to the provisions of that Article.

10.4 GENERAL PROVISIONS RELATED TO CHANGES

- 10.4.1 The Contractor shall not be entitled to any amount for indirect costs, damages or expenses of any nature, including, but not limited to, so-called "impact" costs, labor inefficiency, wage, material or other escalations beyond the prices upon which the proposal is based and to which the parties have agreed pursuant to the provisions of Article 10, and which the Contractor, its Subcontractors or Sub-subcontractors or any other person may incur as a result of delays, interferences, suspensions, changes in sequence or the like, for whatever cause, whether reasonable or unreasonable, foreseeable or unforeseeable, or avoidable or unavoidable, arising from the performance of any and all changes in the Work performed pursuant to this Article 10, unless the delay is caused solely by the Owner or its agent. It is understood and agreed that the Contractor's sole and exclusive remedy in such event shall be recovery of his direct costs as compensable hereunder and an extension of the Contract Time, but only in accordance with the provisions of the Contract Documents. The phrase "Owner or its agent" as used in this Agreement, does not include the Prime_Contractors or their Subcontractors.
- 10.4.2 No claim by the Contractor hereunder shall be allowed if asserted after final payment under this Contract. No claim relating to or flowing from a particular change shall be allowed after execution of the Change Order relating to that change or commencement of the change by the Contractor.

10.5 CHANGES REQUIRING A DECREASE IN CONTRACT SUM.

- 10.5.1 If the Change in the Work will result in a decrease in the Contract Sum, the Owner may request a quotation by the Contractor of the amount of such decrease for use in preparing a Change Order. The Contractor's quotation shall be forwarded to the Owner within ten (10) days of the Owner's request and, if acceptable to the Owner, shall be incorporated in the Change Order. If not acceptable, the parties shall make every reasonable effort to agree as to the amount of such decrease, which may be based on a lump sum properly itemized, on unit prices stated in the Contract Documents and/or on such other basis as the parties may mutually determine. If the parties are unable to so agree, the amount of such decrease shall be the total of the estimated reduction in actual cost of the Work, as determined by the Owner in its reasonable judgment, plus fifteen percent (15%)

thereof as overhead and profit.

10.6 DISPUTES REGARDING CHANGES.

10.6.1 If any dispute should arise between the parties with respect to an increase or decrease in the Contract Sum or an expansion or contraction in the Contract Time as a result of a Change in the Work, the Contractor shall not suspend performance of a Change in the Work or the Work itself unless otherwise so ordered by the Owner in writing. The Owner shall, however, pay to the Contractor up to the Owner's reasonable estimated value of the Change in the Work, regardless of the dispute, if said Change in the Work results in an increase in the Contract Sum; and the Owner shall have the right to decrease the Contract Sum up to the Owner's reasonable estimated value of the Change in the Work, regardless of the dispute, if said Change in the Work results in a decrease in the Contract Sum.

10.7 MINOR CHANGES IN THE WORK

10.7.1 The Owner shall have authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes shall be effected by written order, and shall be binding on the Owner and the Contractor. The Contractor shall carry out such written orders promptly.

10.7.2 The Contractor shall not perform any changes in the Work unless authorized in writing by the Design Consultant or Owner.

10.8 DIFFERING SITE CONDITIONS

10.8.1 Should the Contractor encounter subsurface and/or latent conditions at the site materially differing from those shown on the drawings or indicated in the specifications or differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract, he shall immediately give notice to the Owner of such conditions before they are disturbed. The Owner and the Design Consultant shall thereupon promptly investigate the conditions and if they find that they materially differ from those shown on the drawings or indicated in the specifications, they shall at once make such changes in the drawings and/or specifications as they may find necessary. Any increase or decrease of cost resulting from such changes shall be adjusted in the manner provided herein for adjustments as to extra and/or additional work and changes. However, neither the Owner nor the Design Consultant shall be liable or responsible for additional work, costs or changes to the work due to material differences between actual conditions and any geotechnical, soils and other reports, surveys and analyses made available for the Contractor's review.

10.9 CLAIMS AND DISPUTE RESOLUTION

10.9.1 Definition. A Claim is a demand or assertion by the Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question from the Contractor arising out of or relating to the Contract. Claims must be initiated by written notice. The responsibility to substantiate Claims shall rest with the Contractor.

10.9.2 Time Limits on Claims. Claims by Contractor must be initiated within 10 days occurrence of the event giving rise to such Claim or within 10 days after the Contractor first recognizes the condition giving rise to the Claim, whichever is later, but in no event subsequent to the Contractor's final payment application. Claims must be initiated by written notice to the Design Consultant (if there is one) and the other party.

10.9.3 Continuing Contract Performance. Pending final resolution of a Claim except as otherwise agreed in writing or as otherwise provided in the Contract Documents, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make undisputed payments in accordance with the Contract Documents.

10.9.4 Claims for Additional Cost. If the Contractor wishes to make Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for

Claims relating to an emergency endangering life or property when the giving of such notice would increase the risk of injury or damage to persons or property.

- 10.9.5 Claims for Additional Time. If the Contractor wishes to make Claim for an extension of the dates set for Substantial or Final Completion, written notice as provided herein 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. Contractor bears the burden of proving it is entitled to an extension of time. Unless Contractor meets this burden, Liquidated Damages shall be assessed automatically.
- 10.9.6 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 relevant period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction.
- 10.9.7 Resolution of Claims and Disputes. Claims, including those alleging an error or omission by the Design Consultant, shall be referred initially to the Design Consultant for decision, if there is a Design Consultant with Contract Administration duties which include Claims resolution; otherwise, such Claims by Contractor shall initially be referred to the Owner. An initial decision by such Design Consultant (or Owner as applicable) shall be required as a condition precedent to mediation or litigation of all Claims by the Contractor arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Design Consultant (or Owner as applicable) with no decision having been rendered. The Design Consultant (or Owner as applicable) will not decide disputes between the Contractor and persons or entities other than the Owner.
- 10.9.8 The Design Consultant (or Owner as applicable) will review Claims and within ten days of the receipt of the 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 Design Consultant is unable to resolve the Claim if the Design Consultant lacks sufficient information to evaluate the merits of the Claim or if the Design Consultant concludes that, in the Design Consultant's sole discretion, it would be inappropriate for the Design Consultant to resolve the Claim.
- 10.9.9 Upon receipt of the response or supporting data, if any, the Design Consultant (or Owner as applicable) will either reject or approve the Claim in whole or in part.
- 10.9.10 The Design Consultant (or Owner as applicable) will approve or reject Claims by written decision, which shall state the reasons therefor and which shall notify the parties or any change in the Contract Sum or Contract Time, or both. The approval or rejection of a Claim by the Design Consultant (or Owner as applicable) shall be final and binding on the parties but subject to mediation and litigation.
- 10.9.11 When a written decision of the Design Consultant (or Owner as applicable) states that (1) the decision is final but subject to mediation and litigation and (2) a demand for mediation of a Claim (if required by Owner's Dispute Resolution Procedures) or the commencement of a lawsuit (if mediation is not required as a pre-condition to litigation in Owner's Dispute Resolution Procedures) covered by such decision must be made or done within 30 days after the date on which the party making the demand (or filing the lawsuit) receives the final written decision, then failure to demand mediation in writing (if required) or file the lawsuit within said 30 days' period shall result in the Design Consultant's (or Owner's as applicable) decision becoming final and binding upon the Owner and Contractor. If the Design Consultant (or Owner as applicable) renders a decision after litigation proceedings have been initiated, such decision may be entered as evidence, but shall not supersede litigation proceedings unless the decision is acceptable to all parties concerned.
- 10.9.12 In the event of a dispute, the Owner, Contractor, and other parties involved in the Project shall utilize the Dispute Resolution Procedures adopted by Owner pursuant to N.C.G.S. §143-128(g), if applicable. Owner's Dispute Resolution Procedures are as follows:

These Procedures are applicable to the resolution of disputes with amounts in controversy in excess of \$15,000.00 arising between or among any parties involved in Owner's construction and repair Projects, including the Design Consultant and the Contractors, and the first and lower tier subcontractors, on Claims arising out of the contract or construction process. In no event shall the Owner be subject to arbitration proceedings pursuant to these Procedures. Unless otherwise specified in these Procedures, if there is any

conflict between these Procedures and the other provisions of the Contract Documents, the terms of these Procedures control.

Any Claim as defined in the Contract Documents or any dispute between parties to a construction contract involving the Project, other than the Owner's claims, except those Claims which are waived shall be subject to nonbinding mediation as a condition precedent to the institution of legal proceedings by any party, except that any party may institute legal proceedings in order to meet any applicable statute of limitations or similar deadlines prior to engaging in nonbinding mediation.

The parties shall endeavor to resolve their claims by nonbinding mediation, which, unless the parties mutually agree otherwise, shall be in accordance with rules established by Owner if Owner is a party to the mediation. If Owner is not a party to the mediation, the mediation shall be conducted in accordance with rules established by the parties to the mediation. The parties to the mediation shall share the cost of mediation 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.

- 10.9.13 All suits in law or equity between the Owner and the Contractor arising out of the Contract shall be heard in the appropriate court of justice in the county where the Project is located.

END OF ARTICLE 10

ARTICLE 11

CORRECTION OF WORK

11.1 CORRECTION OF WORK

- 11.1.1 The Contractor shall promptly reconstruct, replace or correct all Work rejected by the Design Consultant as defective or as failing to conform to the Contract Documents or as not in accordance with the guarantees and warranties specified in the Contract Documents whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. The Contractor shall bear all costs of correcting such rejected Work, including compensation for the Design Consultant's and the Owner's additional construction management services made necessary thereby.
- 11.1.2 The Contractor, unless removal is waived by the Owner, shall remove from the site all portions of the Work which are defective or non-conforming, or if permitted or required, he shall correct such work in place at his own expense promptly after receipt of notice, and such rejected Work shall not thereafter be tendered for acceptance unless the former rejection or requirement for correction is disclosed.
- 11.1.3 If the Contractor does not proceed with the correction of such defective or non-conforming Work within a reasonable time fixed by written notice from the Owner, the Owner may either (1) by separate contract or otherwise replace or correct such Work and charge the Contractor the cost occasioned the Owner thereby and remove and store the materials or equipment at the expense of the Contractor, or (2) terminate this Contract for default as provided in Paragraph 12.3. If the Contractor does not pay the cost of such replacement or correction and the removal and storage within ten (10) days thereafter, the Owner may upon ten (10) additional days' written notice sell such Work at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs that should have been borne by the Contractor, including compensation for additional services of the Design Consultant and the Owner made necessary thereby. If such proceeds of sale do not cover all costs, which the Contractor should have borne, the difference shall be charged to the Contractor and an appropriate Change Order shall be issued. If the payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference to the Owner.
- 11.1.4 The Contractor shall bear the cost of making good all work of the Owner or separate contractors destroyed or damaged by such correction or removal.

- 11.1.5 Nothing contained in this Paragraph 11.1 shall be construed to establish a period of limitation with respect to any other obligation, which the Contractor might have under the Contract Documents, including Paragraph 3.5 hereof. The establishment of the time period of one year after the Date of Substantial Completion or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which his 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 his obligations other than specifically to correct the Work.

END OF ARTICLE 11

ARTICLE 12

TERMINATION OF THE CONTRACT

12.1 TERMINATION BY THE CONTRACTOR

- 12.1.1 If the Work is stopped for a period of sixty (60) days under an order of any court or other public authority having jurisdiction, or as a result of an act of government, such as a declaration of a national emergency making materials unavailable, through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing any of the Work under a contract with the Contractor, then the Contractor may, upon seven (7) additional days' written notice to the Owner and the Design Consultant, terminate the Contract and recover from the Owner payment on a quantum merit basis, for all Work executed. The Contractor shall not be entitled to collect and hereby expressly waives, any profit on work not performed or any damages related to that portion of the Contract, which has been terminated.

12.2 TERMINATION FOR CONVENIENCE OF THE OWNER

- 12.2.1 The Owner may, at any time upon ten (10) days' written notice to the Contractor which notice shall specify that portion of the Work to be terminated and the date said termination is to take effect, terminate (without prejudice to any right or remedy of the Owner) the whole or any portion of the work for the convenience of the Owner. The Contractor's sole remedy, in the event of such termination, will be the allowable termination costs permitted by Article 12.4. Contractor shall include termination clauses identical to Article 12 in each of his Subcontracts.

12.3 DEFAULT TERMINATION

- 12.3.1 Subject to the provisions of Paragraph 2.3.1, ten (10) days after written notice is mailed to the Contractor, the Owner may terminate (without prejudice to any right or remedy of the Owner or any subsequent buyer of any portion of the Work) the employment of the Contractor and his right to proceed either as to the whole or any portion of the Work required by the Contract Documents and may take possession of the Work and complete the Work by contract or otherwise in any one of the following circumstances:
- .1 if the Contractor refuses or fails to prosecute the work or any separable part thereof with such diligence as will ensure the Substantial or Final Completion of the Work within the Contract Time or fails to complete the Work or remedy a default within said period;
 - .2 if the Contractor is in material default in carrying out any provisions of the Contract for a cause within his control;
 - .3 if the Contractor fails to supply a sufficient number of properly skilled workmen or proper equipment or materials;
 - .4 if the Contractor fails to make prompt payment to Subcontractors or for materials or labor, unless he otherwise provides the Owner satisfactory evidence that payment is not legally due;

- .5 if the Contractor disregards laws, permits, ordinances, rules, regulations or orders of any public authority having jurisdiction, or fails to follow the instructions of the Owner;
- .6 if the Contractor substantially violates any provisions of the Contract Documents; or
- .7 if the Contractor refuses or fails to properly schedule, plan, coordinate and execute the Work, as specified herein, so as to perform the Work within the specified Milestone and Completion dates, or to provide scheduling or related information, revisions and updates as required by the Contract Documents.

12.3.2 If, after the Contractor has been terminated for default pursuant to Paragraph 12.3, it is determined that none of the circumstances set forth in Subparagraph 12.3.1 exist, then such termination shall be considered a termination for convenience pursuant to Paragraph 12.2 In such case, the Contractor's sole remedy will be the costs permitted by Article 12.4.

12.3.3 If the Owner so terminates the employment of the Contractor, the Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the compensation is to be paid to the Contractor hereunder shall exceed the expense of so completing the Work (including compensation for additional managerial, administrative, consultant and inspection services and any damages for delay) such excess shall be paid to the Contractor.

12.3.4 If such expenses shall exceed the unpaid balance, the Contractor shall be liable to the Owner for such excess. If the right of the Contractor to proceed with the Work is partially or fully terminated, the Owner may take possession of and utilize in completing the Work such materials, appliances, supplies, plant and equipment as may be on the site of the terminated portion of the Work and necessary for the completion of the Work. If the Owner does not fully terminate the right of the Contractor to proceed, the Contractor shall continue to perform the part of the work that is not terminated.

12.4 ALLOWABLE TERMINATION COSTS

12.4.1 If the Owner terminates the whole or any portion of the Work pursuant to Paragraph 12.2, then the Owner shall only be liable to the Contractor for those costs reimbursable to the Contractor in accordance with Subparagraph 12.4.2, plus a markup of ten percent for profit and overhead on the actual fully accounted costs recovered under 12.4.2; provided however, that if there is evidence that the Contractor would have sustained a loss on the entire Contract had it been completed, no profit shall be included or allowed hereunder and an appropriate adjustment shall be made reducing the amount of the settlement to reflect the indicated rate of loss.

12.4.1.1 After receipt of a Notice of Termination, the Contractor shall submit to the Owner his termination claim, in the form and with certification prescribed by the Owner. Such claim shall be submitted promptly but in no event later than three (3) months from the effective date of termination, unless one or more extensions in writing are granted by the Owner upon request of the Contractor made in writing within such three (3) month period or authorized extension thereof. However, if the Owner determines that the facts justify such action, he may receive and evaluate any such termination claim at any time after such three (3) month period or any extension thereof. Upon failure of the Contractor to submit his termination claim within the time allowed, the Owner may determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination.

12.4.2 If the Owner terminates the whole or any portion of the Work pursuant to Paragraph 12.2, the Owner shall pay the Contractor the amounts determined by the Owner as follows:

- .1 an amount for supplies, services, or property accepted by the Owner pursuant to Clause 12.5.1.6 or sold or acquired pursuant to Clause 12.5.1.7 and not heretofore paid for, and to the extent provided in the Contract such amount shall be equivalent to the aggregate price for such supplies or services computed in accordance with the price or prices specified in the Contract, appropriately adjusted for any saving of freight or other charges; and
- .2 the total of:

- (1) the cost incurred in the performance of the Work terminated, including initial costs and preparatory expense allocable thereto, but exclusive of any costs attributable to supplies or services paid or to be paid for under Clauses 12.4.2.1 or 12.4.2.2.(2);
- (2) the cost of settling and paying claims arising out of the termination of Work under Subcontracts or orders, pursuant to Clause 12.5.1.5, which are properly chargeable to the terminated portion of the Work (exclusive of amounts paid or payable on account of completed items of equipment delivered or services furnished by Subcontractors or vendors prior to the effective date of the notice of termination), which amounts shall be included in the costs payable under (1) above; and
- (3) the reasonable costs of settlement, including accounting, legal, clerical and other expenses reasonably necessary for the preparation of settlement claims and supporting data with respect to the terminated portion of the Work and for the termination and settlement of Subcontracts thereunder, together with reasonable storage, transportation and other costs incurred in connection with the protection or disposition of property allocable to the Contract.

.3 Provided, however, that neither the Owner nor the Design Consultant will be liable for payments to Subcontractors pursuant to Article 12.4.2.2 unless each subcontract contains termination provisions identical to those set forth in Article 12. The Owner and the Design Consultant will not be liable to the Contractor for any costs associated with termination if the subcontract of the party involved does not include the proper termination clauses.

12.4.3 In arriving at any amount due the Contractor pursuant to Paragraph 12.4, there shall be deducted the following:

- .1 all unliquidated advance or other payments on account theretofore made to the Contractor applicable to the terminated portion of the Contract;
- .2 any claim which the Owner may have against the Contractor;
- .3 such amount as the Owner determines to be necessary to protect the Owner against loss because of outstanding or potential liens or claims; and
- .4 the agreed price for, or the proceeds of sale of, any materials, supplies or other things acquired by the Contractor or sold, pursuant to the provisions of Clause 12.5.1.7, and not otherwise recovered by or credited to the Owner.

12.4.4 The total sum to be paid to the Contractor under Paragraph 12.4 shall not exceed the Contract Sum as reduced by the amount of payments otherwise made or to be made for Work not terminated and as otherwise permitted by the Contract. Except for normal spoilage, and except to the extent that the Owner shall have otherwise expressly assumed the risk of loss, there shall be excluded from the amounts payable to the Contractor, as provided in Subparagraph 12.4.2, the fair value, as determined by the Owner, of property which is destroyed, lost, stolen or damaged so as to become undeliverable to the Owner, or to a buyer pursuant to Clause 12.5.1.7.

12.4.5 If the Owner terminates the whole or any part of the Work pursuant to Paragraph 12.3, the Owner may procure, upon such terms and in such manner as the Owner may deem appropriate, supplies or services similar to those so terminated, and the Contractor shall be liable to the Owner for any excess costs for such similar supplies or services. The Contractor shall continue the performance of the Contract to the extent not terminated hereunder.

12.5 GENERAL TERMINATION PROVISIONS

12.5.1 After receipt of a notice of termination from the Owner, pursuant to Paragraph 12.2 or 12.3, and except as otherwise directed by the Owner, the Contractor shall:

- .1 stop Work under the Contract on the date and to the extent specified in the notice of termination;

- .2 place no further orders or subcontracts for materials, services or facilities, except as may be necessary for completion of such portion of the work under the Contract as is not terminated;
- .3 terminate all orders and subcontracts to the extent that they relate to the performance of Work terminated by the notice of termination;
- .4 at the option of the Owner, assign to the Owner in the manner, at the times and to the extent directed by the Owner, all of the rights in the contracts so terminated, in which case the Owner shall have the right, at his discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts;
- .5 settle all outstanding liabilities and all claims arising out of such termination or orders and subcontracts, with the approval or ratification of the Owner, to the extent he may require, which approval or ratification shall be final for all the purposes of this Article;
- .6 transfer title and deliver to the entity or entities designated by the Owner, in the manner, at the times and to the extent directed by the Owner to the extent specifically produced or specifically acquired by the Contractor for the performance of such portion of the Work as had been terminated, the following:
 - (1) the fabricated or unfabricated parts, Work in process, partially completed supplies and equipment, materials, parts, tools, dies, jigs and other fixtures, completed Work, supplies and other material produced as part of, or acquired in connection with the performance of, the Work terminated by the notice of termination; and
 - (2) the completed or partially completed plans, drawings, information, releases, manuals and other property related to the Work and which, if the Contract had been completed, would have been required to be furnished to the Owner;
- .7 use his best efforts to sell, in the manner, at the times, to the extent and at the price or prices directed or authorized by the Owner, any property of the types referred to in Clause 12.5.1.6; provided, however, that the Contractor:
 - (1) shall not be required to extend credit to any buyer, and
 - (2) may acquire any such property under the conditions prescribed by and at a price or prices approved by the Owner; and provided further that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the Owner to the Contractor under the Contract or shall otherwise be credited to the Contract Sum covered by the Contract or paid in such other manner as the Owner may direct;
- .8 complete performance of such part of the Work as shall not have been terminated by the notice of termination; and
- .9 take such action as may be necessary, or as the Owner may direct, for the protection and preservation of the property related to the Contract, which is in the possession of the Contractor, and in which the Owner has or may acquire an interest.

12.5.2 The Contractor shall, from the effective date of termination until the expiration of three (3) years after final settlement under the Contract, preserve and make available to the Owner, at all reasonable times at the office of the Contractor, but without direct charge to the Owner, all his books, records, documents and other evidence bearing on the costs and expenses of the Contractor under the Contract and relating to the Work terminated hereunder, or, to the extent approved by the Owner, photographs, micro-photographs or other authentic reproductions thereof.

12.5.3 If the termination, pursuant to Paragraph 12.2, be partial, the Contractor may file with the Owner a claim for an equitable adjustment of the price or prices specified in the Contract relating to the continued portion of the Contract (the portion not terminated by the notice of termination), and such equitable adjustment as may be

agreed upon shall be made in such price or prices. Any claim by the Contractor for an equitable adjustment under this Subparagraph must be asserted within six (6) months from the effective date of the notice of termination.

- 12.5.4 The Contractor shall refund to the Owner any amounts paid by the Owner to the Contractor in excess of costs reimbursable under Paragraph 12.4.
- 12.5.5 The Contractor shall be entitled to only those damages and that relief from termination by the Owner as specifically provided in Article 12.

END OF ARTICLE 12

END OF GENERAL CONDITIONS

In witness whereof, each individual executing this agreement acknowledges that he/she/it is authorized to execute this agreement on behalf of his/her/its principle and further acknowledges the execution of this agreement the day and year first written above.

CONTRACTOR'S SALES TAX REPORT (Appendix A)
N.C. STATE & LOCAL SALES TAXES PAID

OWNER: _____
CONTRACTOR: _____
ADDRESS: _____

PROJECT: _____
FOR PERIOD FROM: _____
TO: _____

VENDOR TAX WAS PAID TO	MATERIAL PURCHASED	ADDRESS	INVOICE NUMBER	DATE	INVOICE AMOUNT	TAXABLE AMOUNT	N.C. TAX	COUNT Y TAX	NAME OF COUNTY
				TOTAL					

I hereby certify that, during the period stated above, all North Carolina sales and use taxes have been paid for the materials, supplies, fixtures, and equipment purchased during that period which have become a part of, or annexed to, a building or structure erected, altered or repaired for the Owner. I further certify that the vendors from whom the property was purchased, the dates and numbers of the invoices covering the purchases, the total amount of the invoices of each vendor, the North Carolina sales and use taxes paid thereon, and the cost of property withdrawn from warehouse stock and North Carolina sales or use taxes paid thereon are as set forth above during the time period noted above.

Sworn to and subscribed before me,

This the ____ day of _____, 20____

Notary Public

Seal

My Commission Expires: _____

Signed: _____

Print Name: _____

Title: _____

CHANGE PROPOSAL FORM
Time and Material / Unit Price Estimate

Project: _____
Contract: _____
Contractor: _____

Proposal #: _____
Project #: _____
Contractor #: _____

Description of change: _____

Materials & Labor

Estimated cost of labor & materials including shipping, overtime, payroll taxes and insurance, and overhead and profit.

Maintain accurate records for billing purposes.

SUBTOTALS

Unit Price Work

Estimated quantity of units required less allowance units not used, times the established unit cost.

Maintain accurate records for billing purposes. Third party records may be required.

Equipment Rental

Estimated cost of equipment rental including shipping, taxes and overhead and profit.

Maintain accurate records for billing purposes.

Subcontractors

Estimated cost of subcontracts including all subcontractor expenses.

Maintain accurate records for billing purposes.

Subtotal of Proposal

*** TOTAL NOT TO EXCEED CHANGE PROPOSAL ESTIMATE**

Time Extension Requests: ____day(s) Schedule Activity # Affected: _____

The Contractor agrees to perform the work outlined in this change proposal for an amount that shall not exceed the amount stated above and in accordance with the Contract documents if the work is authorized by the Owner. If the price to perform the work is expected to exceed the above stated amount, a new change proposal form for the additional work is required.

* Actual amount paid will be based on actual documented expenses.

Contractor's Signature: _____

Date: _____

Approval Recommended by Design Consultant: _____

Date: _____

Owner's Representative Approval: _____

Date: _____

CHANGE PROPOSAL FORM

Project: _____
Contract: _____
Contractor: _____

Proposal #: _____
Project #: _____
Contractor #: _____

Description of change: _____

Materials	(Attach list with Qty, Item, Unit \$, Unit mh, Total mh, OT mh, Total \$)	SUBTOTALS
1 Total Direct Cost of Materials	_____	
2 Overhead & Profit on Item 1. (15% maximum, includes small tools & consumables)	_____ _____	
3 Sales Tax	_____	
4 Shipping & Transportation	_____	
Labor		
5 Total Manhours: _____ MH @ _____ /hr.	_____	
6 Overhead & Profit on Item 5. (15% maximum on straight labor cost, not premium portion) (O & P includes supervisor's time)	_____ _____	
7 Payroll Taxes & Insurance _____ %	_____	
Equipment Rental	(Include quotes)	
8 Equipment Rental	_____	
9 Overhead & Profit on Item 8 (6% maximum).	_____	
Subcontractors	(Include quotes with material & equipment backup)	
10 Subcontractors	_____	
11 Overhead & Profit on Item 10 (6% maximum).	_____	
Subtotal of Proposal		_____

TOTAL OF CHANGE PROPOSAL _____

Time Extension Requests: _____ day(s) Schedule Activity # Affected: _____

The Contractor agrees to perform the work outlined in this change proposal for the amount specified above and in accordance with the Contract documents if the work is authorized by the Owner.

Contractor's Signature: _____

Date: _____

Approval Recommended by Design Consultant: _____

Date: _____

Owner's Representative Approval: _____

Date: _____

SECTION SC

SUPPLEMENTAL CONDITIONS

GENERAL CONDITIONS

Document GC, GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION, constitutes the General Conditions of this Contract, and is hereinafter called "General Conditions." The General Conditions are further revised and supplemented by the provisions of these Supplemental Conditions. The General Conditions and the Supplemental Conditions are applicable to all of the Work under this contract and shall apply to the Contractor and all Subcontractors and Sub-subcontractors.

SUPPLEMENTS:

The following supplements modify, change, delete, or add to the General Conditions. Where any article of the General Conditions is modified or any paragraph deleted, subparagraph or clause thereof is modified, or deleted by these supplements, the unaltered provisions of such article, paragraph, subparagraph or clause shall remain in effect. If there is a discrepancy between the General Conditions and these Supplemental Conditions, the Supplemental Conditions shall control.

ARTICLE 1 - CONTRACT DOCUMENTS

ADD THE FOLLOWING TO SUBPARAGRAPH 1.1.1:

- 1.1.1.1 The Drawings and Specifications referred to in the Contract Documents have been prepared by **Dewberry Engineers Inc.** and are identified by the title:

Clayton Middle School AHU 16 and 17 Replacement

ARTICLE 3 – CONTRACTOR

ADD THE FOLLOWING TO PARAGRAPH 3.21:

- 3.21 The Owner's policies are available for review at www.johnston.k12.nc.us.

ARTICLE 7 – TIME

ADD THE FOLLOWING AS A NEW SECOND SENTENCE TO PARAGRAPH 7.2.1:

The Contractor acknowledges that the coronavirus (COVID-19) pandemic has impacted businesses across the country.

ARTICLE 8 – PAYMENTS AND COMPLETION

ADD THE FOLLOWING TO PARAGRAPH 8.9:

- ~~8.9.1 Substantial Completion Liquidated Damages shall be the sum of Seven hundred fifty dollars (\$750) per calendar day, and this amount shall be assessed in accordance with Subparagraph 8.9.1 of the General Conditions.~~

- ~~8.9.2 Final Completion Liquidated Damages shall be the sum of two hundred fifty dollars (\$250) per calendar day, and this amount shall be assessed in accordance with Subparagraph 8.9.2 of the General Conditions.~~

ADD THE FOLLOWING PARAGRAPH 8.11:

- 8.11.1 The schedule below contains certain specific dates in addition to date of Notice to Proceed and Time for Completion. These dates shall be adhered to and are the last acceptable dates unless modified by mutual agreement between the Contractor and the Owner. All dates indicate midnight unless otherwise stipulated. The only exceptions to this schedule are defined in the General Conditions under Paragraph 7.2 DELAYS AND EXTENSIONS OF TIME.

Notice of Intent to Award – May 13, 2025

Return of Owner Contractor Agreement by Contractor – May 30, 2025

Notice to Proceed – May 30, 2025

Substantial Completion – August 22, 2025

Final Completion – September 26, 2025

- 8.11.2 The Owner reserves the right to withhold the issuance of Notice to Proceed by up to forty-five (45) days. For each day that Notice to Proceed is withheld pursuant to this Subparagraph, the dates established for Substantial Completion and Final Completion shall be adjusted. The contractor shall not be entitled to additional compensation if the owner withholds the issuance of Notice to Proceed pursuant to this Subparagraph.

ARTICLE 9 – INSURANCE AND BONDS

ADD THE FOLLOWING TO PARAGRAPH 9.9:

- 9.9 Separate performance and payment bonds in the total amount of the Contract are required for Contract amounts in excess of \$300,000.

END OF SUPPLEMENTAL CONDITIONS

SUMMARY OF WORK Section 01 11 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Project is: Clayton Middle School AHU 16 and 17 Replacement
 - 1. Project Location:
 - a. Clayton Middle School at 490 Guy Road, Clayton, NC 27520
 - 2. Owner: Johnston County Public Schools
- B. Contract Documents, dated **March 31, 2025** were prepared for the Project by Dewberry Engineers Inc., 2610 Wycliff Road, Raleigh, NC 27607.
- C. The Work generally includes: Replacement of air handling unit 16 and 17 at Clayton Middle School.

.3 CONTRACTOR USE OF PREMISES

- A. Refer to Special Project Procedures Section 01 35 13 and Work Restrictions 01 14 00.

.4 OCCUPANCY REQUIREMENTS

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

.5 MISCELLANEOUS PROVISIONS

- A. None.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 11 00

WORK RESTRICTIONS Section 01 14 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general provisions of the Contract, including General Conditions, other Division 1 Specification Sections, and all other contract bid documents 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 comply with Johnston County Public Schools security badge system.
 - 2. Johnston County Public Schools Occupancy: Allow for Johnston County Public Schools occupancy of site according to the Project Plan.
 - 3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Johnston County Public Schools, Johnston County Public Schools 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.

1.3 SUMMARY

- A. This Section includes a summary of each contract, including responsibilities for coordination and temporary facilities and controls.
- B. Specific requirements of each contract are also indicated in individual Specification Sections, All Bid Documents and on Drawings.

1.4 OCCUPANCY REQUIREMENTS

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

WORK RESTRICTIONS Section 01 14 00

1.5 SPECIAL REQUIREMENTS

- A. Prime and subcontractors are required to comply with Article 2 of Chapter 64 of the North Carolina General Statutes, including but not limited to, the use of E-Verify to verify the legal employment status of its employees.

Each prime and subcontractor shall sign and return their Affidavit of E-Verification to Johnston County Public Schools at the time they return their contract.

If at any time during the project additional workers are hired by the prime or subcontractor, the prime or subcontractor shall notify Johnston County Public Schools, sign and return an Affidavit of E-Verification prior to the new hire beginning work on the project.

If at any time during the project additional prime or subcontractors are added to the project, Johnston County Public Schools shall be notified, and the new prime or subcontractor shall sign and return an Affidavit of E-Verification prior to commencing work on the project.

- B. Criminal Background Investigations of individuals working on school property (sites occupied with students and sites not occupied with students).
- C. At a minimum, the contractor shall obtain a complete North Carolina statewide criminal background investigation for all employees and subcontractors who will work on this project, covering a period for the last seven (7) years. In the event that the contractor or subcontractor is from out of state, the criminal background investigation shall be broadened to include their home state, as well as the state of North Carolina as outlined above. The company providing such information must be recognized by local law enforcement agency as qualified to do so. All costs associated with these criminal background checks is the responsibility of the contractor.

Each prime contractor will be responsible for all their employees and all of their subcontractors working under them.

On sites that are occupied with students and staff, a daily sign-in sheet will be presented by each prime contractor to the principal and SRO – Student Resource Officer by 9:00 a.m. each morning. If there is no SRO – provide to the Principal. This list will contain the name of each person on site and the company they work for.

On sites that are new or unoccupied by students and staff – each prime contractor will provide the daily sign-in sheet to the Owner's Rep who will be designated by the Owner at the Pre-Construction Meeting.

The daily sign in log will be made available to the successful prime contractors at the Pre-Construction Meeting.

- D. Any individual with the following criminal convictions or pending charges will **NOT** be permitted on any school project or property.

Child molestation or abuse;

1. Child molestation or abuse;
2. Child pornography;

WORK RESTRICTIONS Section 01 14 00

3. Repeated domestic violence charges or convictions;
 4. Rape or felony sexual assault;
 5. Any sexually oriented crime;
 6. Drugs: Felony use, possession or distribution within the last 10 years;
 7. Carjacking or automotive theft;
 8. Felonies involving firearms or other deadly weapons;
 9. Felony arson or destruction of property;
 10. Felony theft, burglary, home invasion or robbery;
 11. Felony racketeering or extortion;
 12. Felony kidnapping;
 13. Felony assault, battery, homicide, murder, attempted murder or other violent felony; or
 14. Hate crimes.
- E. Any individual with a prior conviction or pending charges contained in the aforementioned list, shall be banned (not allowed) from any school project or property.
- F. Each person on site must wear a plastic laminated identification badge that identifies the name of the company and the person's name. These badges are to be computer produced at a font large enough to be clearly visible. All costs associated with these criminal background checks is the responsibility of the contractor. The ID badge template will be made available to the successful prime contractors at the Pre-Construction Meeting.
- G. Johnston County Public Schools, may, at any time, request verification of criminal background investigation for any employee or subcontractor on school property.
- H. There is a NO TOBACCO policy on all property owned by Johnston County Public Schools. Therefore, use of any type of tobacco product is prohibited. Workers will be asked to leave the site for the balance of the day on their first offense. Workers will be asked to permanently leave the site after the first offense.
- I. If, in the opinion of the Architect, the General Contractor does not properly water tight the building from the elements – the Owner maintains the right to call in a 3rd party Industrial Hygienist for the purpose of evaluating the infiltration of moisture. This Industrial Hygienist will prepare a report of corrective action necessary to prevent future mold and mildew issues and the General Contractor is solely responsible for the corrective action necessary, as well as all costs associated with the services of the Industrial Hygienist and any additional surface or air quality testing fees that may be required to insure a safe building. No finishes, including drywall work are to commence until the building is permanently enclosed.
- J. All contractors understand and agree that the primary use of an occupied school facility is for the instructional programming to benefit the achievement of the students enrolled in said facility. During periods of standardized and other major testing such as EOG's, etc.. the contractors agree to pursue quiet operations that do not disturb the testing operations. No claims for delay will be considered for these days of quiet operation during periods of testing.
- K. In the event the contractor fails to meet their schedule and this failure to meet the scheduled completion dates affect the delivery of Owner furnished furniture and / or equipment – the Owner has the right (at the sole expense of the contractor) to procure the services of security guards to protect furniture and / or equipment that has been delivered to the project until such time as contractor has met the requirements for the Owner's permanent occupancy of the building

WORK RESTRICTIONS

Section 01 14 00

(Substantial Completion). The Contractor further agrees that they will pay for all handling, shipping and storage costs associated with the storage of furniture and equipment that cannot be delivered and placed in the building due to the Contractor's failure to meet the scheduled completion dates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 14 00

ALLOWANCES Section 01 21 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and provisions of the General Conditions, Supplementary General Conditions, and other Sections included under Division 01, General Requirements, are included as a part of this Section as though bound herein.
- B. Designate in Pay Requests and Schedule of Values separate item for cost allowances. Also breakdown costs as follows:
 - 1. Products/materials
 - 2. Work

1.2 ALLOWANCES FOR PRODUCTS/MATERIAL:

- A. Purchase product/material under allowance only as directed by A/E.
- B. Amount of allowance includes:
 - 1. Net cost of product.
 - 2. Delivery to the site.
 - 3. Applicable taxes.
- C. In addition to amount of allowance, include in bid, for inclusion in Contract Sum, Contractor's cost for:
 - 1. Handling at site including unloading, uncrating, and storage.
 - 2. Protection from elements, from damage.
 - 3. Labor, installation, and finishing.
 - 4. Other expenses (e.g., testing, adjusting, and balancing) required to completed installation.
 - 5. Overhead and profit.

1.3 ALLOWANCES FOR WORK

- A. Provide Work under allowance only as directed by A/E.
- B. Amount of Allowance includes:
 - 1. Net cost of product.
 - 2. Delivery to the site.
 - 3. Applicable taxes.
 - 4. Handling at site including unloading, uncrating, and storage.
 - 5. Protection from elements, from damage.
 - 6. Labor, installation, and finishing.
 - 7. Other expenses required to complete installation.

ALLOWANCES Section 01 21 00

8. A fixed percentage for overhead and profit. Overhead shall include supervision; superintendence; wages of time-keepers, watchmen, and clerks; hand tools, general office expense; and other expenses not included in "cost" under 1. Through 8. Above.
 - a) For Work (labor, materials, and equipment) completed by the Contractor with his own labor, 10 percent shall be added for overhead and profit.
 - b) For Work (labor, materials, and equipment) completed by subcontractor of the Contractor, 5 percent shall be added for overhead and profit.

1.4 SELECTION OF PRODUCT/MATERIAL

A. Architect/Engineer's Duties

1. Consult with Contractor in consideration of product/material and suppliers.
2. Make selection, designate product/material to be used.
3. Notify Contractor in writing, designating:
 - a) Product, size, color, and texture
 - b) Supplier
 - c) Cost, delivered at site

B. Contractor's Duties

1. Assist A/E in determining qualified suppliers.
2. Obtain proposals from suppliers when requested by Architect/Engineer.
3. Make appropriate recommendations for consideration by Architect/Engineer.
4. Notify A/E in writing, of effect anticipated by selection of product or supplier under consideration on:
 - a) Construction Schedule.
 - b) Contract Sum.
5. On notification of selection enter into purchase agreement with designated supplier.
6. Arrange for delivery and unloading.
7. Promptly inspect product for damage or defects.
8. Submit claims for transportation damage.

1.5 ADJUSTMENT OF CASH ALLOWANCES

- A. Unused amounts of moneys included under allowances shall be credited to the Owner by deduct change order prior to approval of Final Application for Payment.

PART 2 – PRODUCTS (NOT APPLICABLE)

ALLOWANCES Section 01 21 00

PART 3 – EXECUTION

3.1 RENOVATION/UNFORESEENS ALLOWANCE

- A. Renovation/Unforeseen Allowance for those items and Work hidden, undetectable, or unforeseen and not visible from pre-bid, on-site observation, or not shown, called-for, or reasonably implied in the Contract Documents and which is in compliance with N.C. Building Code and Division of Facility Services requirements. Refer to Schedule at end of section.

3.2 SCHEDULE OF ALLOWANCES

- A. Allowances for Work: Note: If not described below, refer to Article 1.3 for description of what is included in the allowance.

- B. Allowance No. 1: Schedule of Allowances

B.1. Lump Sum Allowance: Include a \$5,000 allowance/contingency for unforeseen conditions during construction. If this is not used, it will be credited back to JCPS at the end of the project.

END OF SECTION 01 21 00

ALTERNATES Section 01 23 00

West Campus Chiller Replacement

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general provisions of the Contract, including General Conditions, other Division 1 Specification Sections, and all other contract bid documents apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for alternates.
- B. Specific requirements of each contract are also indicated in individual Specification Sections, All Bid Documents and on Drawings.

1.3 DEFINITIONS

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

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Prior to award of the Contract, the Architect will notify each party involved, in writing, of the status of each alternate. The Architect will indicate if alternates have been accepted, rejected, or deferred for later consideration. The Contractor agrees to honor pricing on Bid Alternates for a period of 120 calendar days.
- C. Execute accepted alternates under the same conditions as other work of the Contract.

ALTERNATES

ALTERNATES

Section 01 23 00

- D. Schedule: A Schedule of Alternates is included at the end of this Section. The Bid Documents contain technical requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate #1: Manufacturer Preferred Brand of BAS Controls: Climatec (formerly ECS)
- B. Alternate #2: Manufacturer Preferred Brand of Fan: Loren Cook
- C. Alternate #3: Manufacturer Preferred Brand of VFD: ABB

END OF SECTION 01 23 00

ALTERNATES

SUBSTITUTIONS PROCEDURES Section 01 25 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling requests for substitutions made after award of the Contract.
- B. The Contractor's Construction Schedule and the Schedule of Submittals are included under Section "Submittals."
- C. Standards: Refer to Section "Definitions and Standards" for applicability of industry standards to products specified.
- D. Procedural requirements governing the Contractor's selection of products and product options are included under Section "Materials and Equipment."

.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions." The following are not considered substitutions:
 - 1. Substitutions requested by Bidders during the bidding period, and accepted prior to award of Contract, are considered as included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
 - 2. Revisions to Contract Documents requested by the Owner or Dewberry Engineers Inc.
 - 3. Specified options of products and construction methods included in Contract Documents.
 - 4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

.4 SUBMITTALS

- A. Substitution Request Submittal: Requests for substitution will be considered if received within 30 days after commencement of the Work. Requests received more than 30 days after commencement of the Work may be considered or rejected at the discretion of the Dewberry Engineers Inc.

SUBSTITUTIONS PROCEDURES Section 01 25 00

1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.
2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
 - b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
 - c. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
 - d. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - e. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - f. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
3. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will request additional information or documentation necessary for evaluation of the request. Within 2 weeks of receipt of the request, or one week of receipt of the additional information or documentation, whichever is later, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance will be in the form of a Change Order.

PART 2 - PRODUCTS

.1 SUBSTITUTIONS

- A. Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
 1. Extensive revisions to Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of Contract Documents.
 3. The request is timely, fully documented and properly submitted.
 4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.

SUBSTITUTIONS PROCEDURES Section 01 25 00

5. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.
 8. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
 9. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
 10. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provide the required warranty.
- B. The Contractor's submittal and Engineer's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 25 00

MODIFICATION PROCEDURES Section 01 26 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 01 Section "Submittals" for requirements for the Contractor's Construction Schedule.
 - 2. Division 01 Section "Applications for Payment" for administrative procedures governing Applications for Payment.
 - 3. Division 01 Section "Product Substitutions" for administrative procedures for handling requests for substitutions made after award of the Contract.

.3 MINOR CHANGES IN THE WORK

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

.4 CHANGE ORDER PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: The Engineer will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal requests issued by the Engineer are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
 - 2. Within 10 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.
 - a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

MODIFICATION PROCEDURES Section 01 26 00

- c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
- B. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Engineer.
 1. Include a statement outlining the 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 Contract Time.
 2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.
- C. Proposal Request Form: Use **Change Order Proposal Form** for Change Order Proposal Requests.
 1. Include sufficient documentation of quantities and unit prices to allow evaluation of quantities with respect to the work required and the intent of the change. Require subcontractors to provide comparable documentation for their work.
 2. Do not use lump sum pricing for any trade or subcontract in excess of \$500.00.
 3. Permit charge for overhead and profit determined as follows:
 - a. for the Contractor, for any work performed by his employees or agents 10% of the costs. Deduct 5% for deductive change orders;
 - b. for the Contractor, for work performed by his Subcontractor, 5% of the amount due the subcontractor; and
 - c. for each Subcontractor, for work performed by such Subcontractor, his employees and agents, 10% of the costs.
 - d. "Costs" shall not include home-office charge or expenses, supervisions, superintendents, wages of time keepers, watchmen and clerks, small tools, incidentals, general office expense and all other expenses generally constituting overhead or general conditions. The proposals from the contractor for extra work shall include a breakdown showing cost for materials, labor, insurance and overhead and profit and bonds.
 4. The maximum total combined markup for bonds and insurance will be two (2) percent of the total amount.

.5 ALLOWANCES

- A. Allowance Adjustment: For allowance-cost adjustment, base each Change Order Proposal on the difference between the actual purchase amount and the allowance, multiplied by the final measurement of work-in-place. Where applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 1. Include installation costs in the purchase amount only where indicated as part of the allowance.
 2. When requested, prepare explanations and documentation to substantiate the margins claimed.
 3. The Owner reserves the right to establish the actual quantity of work-in-place by independent quantity survey, measure, or count.

MODIFICATION PROCEDURES Section 01 26 00

- 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 the Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. The Owner will reject claims submitted later than 21 days.
 - 1. Do not include the 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 Contract Documents.
 - 2. No change to the 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.

.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: When the Owner and the Contractor disagree on the terms of a Proposal Request, the Engineer may issue a Construction Change Directive on AIA Form G714 or similar form. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or 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 the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

.7 CHANGE ORDER PROCEDURES

- A. Upon the Owner's approval of a Proposal Request, the Engineer will issue a Change Order for signatures of the Owner and the Contractor on AIA Form G701.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 26 00

Request for Information Section 01 26 13

Date: _____

Johnston County Public Schools
Clayton Middle School AHU 16 and 17 Replacement

To: Dewberry Engineers Inc.
2610 Wycliff Road, Suite 410
Raleigh, NC 27607
Attn: Weston Hockaday
whockaday@dewberry.com

RFI Number: _____

In reference to the above listed project, we are hereby requesting a clarification, determination and/or information concerning the following:

Section Number: _____ Drawing Number: _____

Requested By: _____ Date of Request: _____

Title: _____ Date Reply Required: _____

In reply to your request, be advised: _____

Reply By: _____ Date of Reply: _____

Title: _____ Date Reply Returned: _____

PAYMENT PROCEDURES Section 01 29 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 SUMMARY

- A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section "Submittals."

.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
 - a. Contractor's Construction Schedule.
 - b. Application for Payment forms, including Continuation Sheets.
 - c. Schedule of allowances.
 - d. List of products.
 - e. List of principal suppliers and fabricators.
 - f. Schedule of submittals.
 - 2. Submit the Schedule of Values to the Engineer at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish the format 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 the Engineer.
 - c. Project number.

PAYMENT PROCEDURES Section 01 29 00

- d. Contractor's name and address.
 - e. Date of submittal.
2. 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 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 Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
- a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Margins of Cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.
- b. 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 the Contractor's option.
8. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by the Owner.

PAYMENT PROCEDURES Section 01 29 00

1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
- B. Payment-Application Times: The date for each progress payment application is the seventh day of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 7 days prior to the date for each progress payment.
- C. Payment-Application Forms: Use AIA Document G702 and Continuation Sheets G703 as the form for Applications for Payment. Use the Sales Tax form to report applicable state and county sales taxes. Include a completed Payment Application Cover Sheet with each application.
- D. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Engineer will return incomplete applications without action.
 1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
 2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.
- E. Sales Tax Summary – The project is subject to a sales tax rebate for the Owner. Each contractor and subcontractor shall submit a summary of payments made and invoices received including sales taxes for the month being billed. Each contractor shall maintain these accounts on the form included in this project manual entitled Certificate Concerning North Carolina State and County Sales Tax (hereinafter referred to as the “Sales Tax Form”. All supporting documentation is required on a monthly basis along with the payment application. Supporting documentation is identified on the form. When the Contractor submits multiple Sales Tax Forms, he shall also provide a notarized summary form that lists each Subcontractor and the taxes reported by that subcontractor. A total for each column shall be computed and reported on this summary sheet. This summary sheet shall be the first sheet of the sales tax reports submitted.
- F. Transmittal: Submit two (2) signed and notarized original copies of each Application for Payment (including separately notarized sales tax reports) to the Engineer by a method ensuring receipt within 24 hours. Both copies shall be complete, including waivers of lien and similar attachments, when required.
 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Engineer.
- G. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics liens from subcontractors, sub-subcontractors and suppliers for the construction period covered by the previous application.
 2. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item. Retainage is to be calculated at a rate of 5% and will be withheld in accordance with the requirements set forth in the N.C. General Statutes
 3. When an application shows completion of an item, submit final or full waivers.
 4. The Owner reserves the right to designate which entities involved in the Work must submit waivers.

PAYMENT PROCEDURES Section 01 29 00

5. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to the Owner.
- H. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:
 1. List of subcontractors.
 2. List of principal suppliers and fabricators.
 3. Schedule of Values.
 4. Contractor's Construction Schedule (preliminary if not final).
 5. Schedule of principal products.
 6. Submittal Schedule (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. List of Contractor's principal consultants.
 9. Copies of building permits.
 10. Copies of authorizations and licenses from governing authorities for performance of the Work.
 11. Initial progress report.
 12. Report of preconstruction meeting.
 13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire the Owner's insurance.
 16. Initial settlement survey and damage report, if required.
 17. Completed Payment Application coversheet, and all items itemize thereon.
- I. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
 1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Startup performance reports.
 - f. Final cleaning.
 - g. Application for reduction of retainage and consent of surety.
 - h. Advice on shifting insurance coverages.
 - i. Final progress photographs.
 - j. List of incomplete Work, recognized as exceptions to Engineer's Certificate of Substantial Completion.
- J. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:

PAYMENT PROCEDURES

Section 01 29 00

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Ensure that unsettled claims will be settled.
4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
5. Transmittal of required Project construction records to the Owner.
6. Proof that taxes, fees, and similar obligations were paid.
7. Removal of temporary facilities and services.
8. Removal of surplus materials, rubbish, and similar elements.
9. Submit Appendix E MBE Documentation for Contract Payments as documentation of payment to minority businesses for work on the Project.
10. Submit Lien Waivers from subcontractors and major equipment suppliers.
11. Submit Affidavit of Payment of Debts and Claims with all supporting documentation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 29 00

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general provisions of the Contract, including General Conditions, other Division 1 Specification Sections, and all other contract bid documents 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. Conservation.
 - 3. Coordination Drawings.
 - 4. Administrative and supervisory personnel.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.
- C. Specific requirements of each contract are also indicated in individual Specification Sections, All Bid Documents and on Drawings.

1.3 COORDINATION

- A. Coordination: The General Contractor shall coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. The GC shall coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation. The GC shall be the Project Expediter and Project Coordinator on this project.
 - 1. The GC shall 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.
- B. If necessary, all Prime Contractors shall 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.

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

1. Prepare similar memoranda for architect, Owner, Owner's rep & Program / Construction Manager and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: The GC shall 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: It is the responsibility of all Prime Contractors to coordinate with GC in the preparation of all scheduling and coordination issues.
 1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.4 SUBMITTALS

- A. Staff Names: Within 5 working days of starting construction operations, all Prime Contractors will submit a list of principal staff 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.
- B. 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.

1.5 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.

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

1.6 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 architect, Owner, Owner's rep & Program / Construction Manager, of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees at least 3 days prior to the scheduled meeting.
 - 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including, architect, Owner, Owner's rep & Program / Construction Manager within 2 days of the meeting.
- B. Preconstruction Conference: The architect will schedule a pre-construction conference, at a time convenient to contractors, architect, Owner, Owner's rep & Program / Construction Manager, but no later than 10 days after notice to proceed. The conference will be at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
 - 1. Attendees: Authorized representatives of architect, Owner, Owner's rep & Program / Construction Manager, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing.
 - d. Designation of responsible personnel.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for processing Applications for Payment.
 - g. Distribution of the Contract Documents.
 - h. Submittal procedures.
 - i. Preparation of Record Documents.
 - j. Use of the premises.
 - k. Responsibility for temporary facilities and controls.
 - l. Parking availability.
 - m. Office, work, and storage areas.
 - n. Equipment deliveries and priorities.
 - o. First aid.
 - p. Security.
 - q. Progress cleaning.
 - r. Working hours.

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

- C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction. These Pre-Installation meetings shall include all work scopes / trades as directed by architect, Owner, Owner's rep & Program / Construction Manager.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise architect, Owner, Owner's rep & Program / Construction Manager 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 Change Orders.
 - d. Purchases.
 - e. Deliveries.
 - f. Submittals.
 - g. Review of mockups.
 - h. Possible conflicts.
 - i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written recommendations.
 - m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Required performance results.
 - u. Protection of construction and personnel.
 - v. Review of the "Project Plan".
 3. Record significant conference discussions, agreements, and disagreements.
 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to architect, Owner, Owner's rep & Program / Construction Manager, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work within 24 hours of notification of an issue needing action by one or more parties.

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time. (See Section 01311 for specific scheduling requirements).
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.
 - 14) Documentation of information for payment requests.
3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
 - 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.
- E. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
 1. Attendees: In addition to architect, Owner, Owner's rep & Program / Construction Manager each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work
 2. Agenda: Review and correct or approve minutes of 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

PROJECT MANAGEMENT & COORDINATION

Section 01 31 00

- 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: General Contractor to record meeting results and distribute copies within 2 working days to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PRODUCTS (Not Used)

EXECUTION (Not Used)

END OF SECTION 01 31 00

CONSTRUCTION PROGRESS DOCUMENTATION

Section 01 32 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 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. Schedule.
 - 2. Submittals Schedule.
 - 3. Daily construction reports.
 - 4. Material location reports.
 - 5. Field condition reports.
 - 6. Special reports.
 - 7. Construction photographs.
- B. Specific requirements of each contract are also indicated in individual Specification Sections, All Bid Documents and on Drawings.
- C. Construction Photographs: Submit two prints of each photographic view (4 views total) within five working days of taking photographs, must be submitted with each monthly pay application.
 - 1. Format: Digitally formatted in a manner acceptable to the architect, Owner, Owner's rep & Program / Construction Manager, and provided electronically.
 - 2. Identification: On each print, provide an electronically applied label with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect and Owner.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - 3. Negatives: Submit a complete set of photographic negatives or diskette containing electronic image file in protective envelopes with each submittal of prints. Identify date photographs were taken.

CONSTRUCTION PROGRESS DOCUMENTATION

Section 01 32 00

- D. Daily Construction Reports: Submitted Daily to architect, Owner, Owner's rep & Program / Construction Manager in a format as defined by Owner (including electronic formats such as Primavera Expedition).
- E. Material Location Reports: Submit as required by architect, Owner, Owner's rep & Program / Construction Manager.
- F. Field Condition Reports: Submitted to architect, Owner, Owner's rep & Program / Construction Manager in a format as defined by architect, Owner, Owner's rep & Program / Construction Manager (including electronic formats such as Primavera Expedition).
- G. Special Reports: Submitted per occurrence to Architect and Owner's Representative in a format as defined by architect, Owner, Owner's rep & Program / Construction Manager (including electronic formats such as Primavera Expedition).

1.3 QUALITY ASSURANCE

- 1. Photographer Qualifications: Digital photos of high quality taken by the General Contractor are acceptable.

1.4 COORDINATION

- A. Auxiliary Services: Cooperate with other trades, architect, Owner, Owner's rep & Program / Construction Manager, and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

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

CONSTRUCTION PROGRESS DOCUMENTATION

Section 01 32 00

- b. Submittals must be logged and maintained in a format as defined by architect, Owner, Owner's rep & Program / Construction Manager, (including electronic formats such as Primavera Expedition).

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

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 Johnston County Public Schools: Include a separate activity for each portion of the Work performed by Johnston County Public Schools.
4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date. Delivery dates indicated stipulate the earliest possible delivery date.
5. Johnston County Public Schools -Furnished Products: Include a separate activity for each product. Include delivery date. Delivery dates indicated stipulate the earliest possible delivery date.
6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion. (Show staff occupying the building to set up classes & stocking at least 30 days prior to the contract substantial completion date).
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.

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8. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Permanent space enclosure.
 - c. Completion of mechanical installation.
 - d. Completion of electrical installation.
 - e. Substantial Completion.
9. Responsibilities: Identify each activity according to the responsibility for that activity. Responsibilities categorization of activities shall include
 - a. Johnston County Public Schools
 - b. Architect
 - c. City or County Agency having jurisdiction
 - d. General Contractor
 - e. Mechanical Contractor
 - f. Plumbing Contractor
 - g. HVAC Contractor
 - h. Electrical Contractor
 - i. Technology Contractor
 - j. Others having prime contracts

The purpose of this responsibility is to sort the schedule by entities having prime agreements with Johnston County Public Schools, Architect, agencies having jurisdiction. Establish secondary responsibilities in a separate activity definition for the purposes of sorting by subcontractors for the contractor's convenience.

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. High and low temperatures and general weather conditions.
 5. Accidents.
 6. Meetings and significant decisions.
 7. Unusual events (refer to special reports).
 8. Stoppages, delays, shortages, and losses.
 9. Meter readings and similar recordings.
 10. Emergency procedures.
 11. Orders and requests of authorities having jurisdiction.

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12. Change Orders received and implemented.
 13. Construction Change Directives received.
 14. Services connected and disconnected.
 15. Equipment or system tests and startups.
 16. Partial Completions and occupancies.
 17. Substantial Completions authorized.
- B. Material Location Reports: At intervals as required by the architect, Owner, Owner's rep & Program / Construction Manager, prepare 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 a detailed report. Submit with a request for information on Primavera Expedition. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to architect, Owner, Owner's rep & Program / Construction Manager, within one day of an occurrence. Distribute copies of report to parties affected by the occurrence by way of Primavera Expedition.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise architect, Owner, Owner's rep & Program / Construction Manager, in advance when these events are known or predictable.

END OF SECTION 01 32 00

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Clayton Middle School AHU 16 and 17 Replacement

1.01 GENERAL REQUIREMENTS

- A. The work under this contract shall be planned, scheduled, executed and reported using the Critical Path Method (hereinafter referred to as: CPM), pursuant to the provisions of the General Conditions. Any deviation between this scheduling specification and the General Conditions shall be governed by the more stringent spec at the full discretion of the Engineer, Owner, Owner's rep & Program / Construction Manager.
- B. The primary objectives of the project scheduling program are to insure the adequate planning, scheduling and execution of the construction activities so they may be prosecuted in an orderly and expeditious manner, within the Contract Time and the milestones stipulated by the Contract, to provide optimum coordination between contractors, to establish the basis for measuring and monitoring individual contractor progress and overall project progress, to detect problems for the purpose of taking corrective action to maintain the scheduled program and to provide a mechanism or tool for determining and monitoring such corrective actions.
- C. Any schedule templates prepared for this project by the owner are made available by the Owner solely as an aid to the Contractor. Any construction plan depicted in the schedule template may not optimize, and it is not intended to optimize, the Bidder's costs or resources. It is intended that these schedules will reflect the milestones and completion dates established by the Owner. However, the services provided by the Engineer, Owner, Owner's rep & Program / Construction Manager, the existence of schedules, networks, or any other charts or services prepared or performed by the Engineer, Owner, Owner's rep & Program / Construction Manager shall in no way relieve the Contractor and/or Project Expediter of the responsibility of complying with all of the requirements of the Contract Documents, including but not limited to the responsibility of completing the Work within the Contract Time and the responsibility of planning, scheduling and coordinating the work. The Contractor is required to comply with all control procedures specified herein and with any reasonable changes that may be necessary, in the opinion of the Engineer, Owner, Owner's rep & Program / Construction Manager, or that are provided to the contractor regarding key dates, during the contract duration.
- D. Any and all milestone or specific Dates listed in these specifications, or elsewhere in the Contract Documents, represent only the major items of construction/erection work or interface dates. The milestone completion dates indicated are considered essential to the satisfactory performance of this Contract and to the coordination of all work on the project.

The milestone dates listed are not intended to be a complete listing of all work under this Contract or of all interfaces with other project contractors.

The milestone dates listed represent the latest allowable completion dates. Earlier completion dates may be established by the Project Expediter as agreed by the Contractor(s), Engineer, Owner, Owner's rep & / or Program / Construction Manager.

- E. If the Contractor should desire or intend to complete the work earlier than any required Milestone or Completion date, the Engineer, Owner, Owner's rep & Program /

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Construction Manager shall not be liable to the Contractor for any costs or other damages should the contractor be unable to complete the Work before such Milestone or Completion date. The duties, obligations and warranties of the Owner to the Contractor shall be consistent with and applicable only to the completion of the Work on the Milestone and completion dates required in the Owner-Contractor Agreement, unless the Owner and Contractor otherwise agree in writing.

F. THE GENERAL CONSTRUCTION CONTRACTOR IS THE PROJECT EXPEDITER / COORDINATOR AND HAS THE DUTY OF SCHEDULE PREPARATION, COORDINATION, UPDATING & REPORTING.

1.02 PRE-BID

A. The Owner reserves the right to the following prior to the receipt of bids:

1. Engineer, Owner, Owner's rep & Program / Construction Manager or a third party scheduling consultant may prepare a Preliminary Provisional Network, which displays a construction plan to complete the Project in compliance with Specific Dates listed in the Bid Documents..
 - a. The Engineer, Owner, Owner's rep & Program / Construction Manager make no warranty or representation either express or implied, as to the reasonableness of or feasibility of the fact that this Preliminary Provisional Network may be a complete listing of all of the Work activities required by this Contract.
 - b. Each Bidder is under the obligation of reviewing and analyzing the Preliminary Provisional Network and determining its feasibility and reasonableness with regard to the activities required by the Contract Documents, the duration of such activities and the sequence of work required in order to complete the work within the contract time.
2. At the sole discretion of the Owner the Engineer, Owner, Owner's rep & Program / Construction Manager may conduct a Pre-Bid Conference to familiarize bidders with the Project and the Preliminary Provisional Network, if supplied.

1.03 POST AWARD ACTIVITIES

A. The Contractor shall perform the following after receipt of the Notice to Proceed.:

Immediately following the receipt of Notice to Proceed,, the General Contractor shall commence the preparation of the Detailed Construction Schedule. In this respect and prior to the next meeting with the Engineer, Owner, Owner's rep & Program / Construction Manager, the Contractor shall assemble, with the assistance of his Subcontractors and Suppliers, information regarding the project that includes but is not limited to:

1. A Detailed Construction Schedule that represents the Contractor's best judgment in how he shall prosecute and complete the work in compliance with the Contract Milestone Dates and any Specific Dates stipulated in the General Conditions or other contract documents.

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2. The identity and duration of all activities to be included in this construction plan shall meet the following criteria:
 - (A) Activity descriptions shall be clear and concise. The beginning and end of each activity shall be readily verifiable.
 - (B) Responsibility for each activity shall be identified with a single performing organization. (i.e., Primes, suppliers, vendors and all sub-contractor)
 - (C) The cost component for each activity shall be provided, if requested by the Owner. The sum of the activity cost components shall equal the contract price.
 - (D) An activity must be no more than 14 calendar days in duration unless approved in advance by the Engineer, Owner, Owner's rep & Program / Construction Manager.
 - (E) Include relevant predecessors and successors for each activity as well as the type of relationships between, and any lag time required. All activities except the first activity (i.e., NTP) and last activity (i.e., Final Completion) shall have both predecessors and successors.
 - (F) Listing of Project submittals, approvals, and material/equipment site deliveries dates.
 3. The identity of planned and reasonably anticipated inclement weather as identified in Article 4.3.7.2 of the General Conditions.
 4. The identity of long lead items and delivery dates of all major pieces of equipment or materials.
 5. The schedule must be resource loaded and identify the contractor performing the work and the number of workers needed to perform each activity.
- B. The General Contractor shall, within **fourteen (14) calendar days** following Notice to Proceed, submit to the Engineer, Owner, Owner's rep & Program / Construction Manager, **a Computerized Construction Schedule** in precedence format that is acceptable to the owner.
- . The Detailed Construction Schedule shall show:
- a. The order and interdependencies of the contractor's activities and the major points of interface or interrelation with the activities of others, including Specific Dates for completion.
 - b. Conformance with and identification of the specified mandatory milestone dates specified in the Contract Documents.
 - c. The description and quantity of work by activity.

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- d. The time required for engineering, preparation and approval of shop drawings, manufacturing, and delivery of Contractor-furnished permanent plant materials.
 - e. The time required for procurement, delivery, and erection of the Contractor's permanent plant materials.
 - f. Delivery of Owner-furnished material and equipment.
 - g. Shop fabrication and delivery.
 - h. Critical Path (or Paths).
 - i. Erection and installation.
 - j. Testing of equipment and materials.
 - k. Activity calendars, Incorporating potential weather delays, or multi- work periods.
- C. The Detailed Construction Schedule shall indicate an early completion date for the project that is no later than the project's required completion date. All activity duration's shall be given in work days. The Schedule shall also indicate each of the following:
- 1. Interfaces with the work of outside contractors, e.g., utilities, power, and with any separate contractor.
 - 2. Estimated duration time for each activity.
 - 3. Early start date for each activity.
 - 4. Late start date for each activity.
 - 5. Early finish date for each activity.
 - 6. Late finish date for each activity.
 - 7. Float available for each path of activities containing float.
 - 8. Actual start date for each activity begun.
 - 9. Actual finish date for each activity completed.
 - 10. Identification of all critical path activities in the schedule analysis.
 - 11. The critical path for the project, with said path of activities being clearly and easily recognizable on the time-scaled network diagram. The relationship between all non-critical activities and activities on the critical path shall be clearly shown on the network diagram.
 - 12. The dollar value of each activity in relation to the schedule of values, if required by the Owner.

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13. The responsibility code for the Contractor or Subcontractor performing each activity or portion thereof.
- D. The Engineer, Owner, Owner's rep & Program / Construction Manager will review the Contractor's Detailed Construction Schedule, for compatibility with the Project Milestones, Completion Schedule and Project Expeditors' Schedule. If requested, a meeting will be held between the Engineer, Owner, Owner's rep & Program / Construction Manager and Contractor to resolve any conflicts in the Contractor's schedule. The Contractor shall revise his schedule as required by the Engineer, Owner, Owner's rep & Program / Construction Manager to ensure completion of the Project in accordance with the Project's Milestone and Completion Dates and shall submit his revised schedule to the Engineer, Owner, Owner's rep & Program / Construction Manager within five (5) calendar days.
- E. Within **fourteen (14) calendar days** following Notice to Proceed, the Contractor shall submit a Schedule of Values for review by the Engineer, Owner, Owner's rep & Program / Construction Manager. The Schedule of Values will allocate a dollar value (cost) for each activity. Each activity cost allocation shall include a labor, equipment and material cost and a pro rata contribution to overhead and profit. The sum of all activity costs shall be equal to the total Contract Sum. Each activity cost shall be coded with a cost code corresponding to the subcontractor responsible for performing the Work so that subtotals for each division of the Work can be prepared.
- F. Approval by the Engineer, Owner, Owner's rep & Program / Construction Manager of the Project Expediter's Project Construction Schedule is advisory only and shall not relieve the Contractors of the responsibility for accomplishing the Work within each and every Contract-required Milestone and Completion date. Omissions and errors in the approved Project Construction Schedule shall not excuse performance which is not in compliance with the contract. Acceptance by the Engineer, Owner, Owner's rep & Program / Construction Manager in no way makes the Engineer, Owner, Owner's rep & Program / Construction Manager an insurer of the Project Construction Schedule's success or liable for time or cost overruns flowing from its shortcomings. The Owner hereby disclaims any obligation or liability by reason of Engineer, Owner, Owner's rep & Program / Construction Manager acceptance of or acquiescence to the Project Construction Schedule.
- G. The **Project Expediter / General Contractor** shall compile, organize, and present a fully integrated Computerized Project Construction Schedule to the Engineer, Owner, Owner's rep & Program / Construction Manager within **fourteen (14) calendar days** of Notice to Proceed. The Project Expediter shall provide five (5) hard copies of the Detailed Construction Schedule, and one electronic Primavera P6 compatible file copy, the Schedule of Values and Computer Reports to the Engineer, Owner, Owner's rep & Program / Construction Manager and Prime Contractors for final review and acceptance. The Project Expediter shall use the approved Project Construction Schedule in planning, organizing, directing, coordinating, performing and executing the work (including all activities of Subcontractors, equipment deliveries, vendors, and suppliers) and shall be the basis for evaluating the progress of the Work, subject to such revisions made in such schedule as provided for herein or in the Contract Documents.
- H. The **Project Expediter** will develop and maintain the overall Project Construction Schedule, of which the Contractor's Detailed Construction Schedule will be a part. This

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schedule will be in precedence format and will be computer generated and updated and with the inclusion of the approved prime contractor schedules will be the controlling schedule document utilized for managing overall project construction.

1.04 COMPUTER COST AND SCHEDULE REPORTS

A. Every month the Project Expediter will generate all monthly Prime contractors' progress documents (i.e., monthly Turn-a-round Documents and the progress payment application Cost/Schedule Reports) from the Detailed Construction Schedule, based on the Progress Reports received from the Contractors. These Reports will reflect the progress of the project in respect to both cost and time.

B. Report Content:

1. The initial and subsequent Schedule Reports shall include the following minimum information for each activity: activity number, by total float (from the least to the most), and late start date, in chronological order:

- a. activity number
- b. activity description
- c. estimated duration in days
- d. early and late start dates
- e. early and late finish dates
- f. percentage of activity completed as of each report
- g. total float-positive/days behind schedule-negative
- h. responsibility for activity.

The Project Expediter will produce monthly (4) four schedule reports. The reports are:

1. All activities on the Project Construction Schedule sorted by activity number.
 2. Activity by Prime Contractor sorted. Further sorted by activity number.
 3. All activities for prime contractors sorted by total float.
 4. All activities by late start in chronological order.
2. The initial and subsequent Cost Reports shall include the following activity information sorted by trade:
- a. activity number
 - b. activity description

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- c. current month percentage of value of work in place against Total Value
- d. previous month percentage of value of work in place against Total Value
- e. total cost of each activity

1.05 UPDATES

- A. An updated project schedule shall be provided at each construction progress meeting.
- B. Each updated schedule must include the original base line schedule that was accepted by the Engineer, Owner, Owner's rep & Program / Construction Manager, and signed by each Prime Contractor. It also needs to reflect actual progress and anticipated completion durations.

1.06 PROGRESS PAYMENTS

- A. Five (5) calendar days prior to the date of application for Progress Payment, **each Prime Contractor's Project Manager and Superintendent**, the Engineer, Owner, Owner's rep & Program / Construction Manager shall meet at the job site for the purpose of reviewing the Contractor's report of actual progress, and obtaining from the Contractor (following his meeting with all concerned Subcontractors and suppliers) up-to-date and accurate progress data.
- B. Before the date of Application for Progress Payment, the Project Expediter shall produce copies of all reports referred to in the contract documents.
- C. The submission and approval of progress updates and the reports calculating the value of work done for any given pay period for each activity based on the percentage complete for that activity less the amount previously paid for past percentages complete and percent of retainage shall be an integral part and basic element of the application upon which Progress Payments shall be made pursuant to the provisions of the General Conditions. The Contractor shall be entitled to progress payments only as determined from the current updated and approved Project Cost Report. Each month the updated and approved Project Cost Report shall be attached to AIA form G702 in submitting payment applications.
- D. Due to the fact that the Schedules and Reports System may not be fully operational before thirty (30) days after the Notice to Proceed, the Contractor may be due one Provisional Progress Payment for mobilization, overhead, procurement of bonds and insurance, and general conditions. However, no payment for work will be approved until the Contractor has complied with the provisions of this Section.
- E. The following outlines the Contractor's pay cycle process Payment cycle (Payment check issued on approximately the 15th on the following month):
 - 1. Current month construction progress status approved by Design Consultant by 20th of the month.

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2. Current month Payment Application approved by Design Consultant, and Owner by 25th of the month.

2.00 CONTRACTOR'S ORGANIZATION

The Contractor shall maintain, as part of its organization, a staff/or consultant of sufficient knowledge in the use and application of CPM in a Primavera P6 compatible format and whose responsibility will be to prepare input information for the Detailed Construction Schedule, monitor progress, provide input for updating and revise logic diagrams when necessary.

2.01 SPECIFIC DATES

The Contractor is required to adhere to the Specific Dates as set forth in the Contract Documents.

2.02 RECOVERY SCHEDULE

Pursuant to the General Conditions, should the Project Coordinator / Expediter's approved Project Construction Schedule fall behind schedule to the extent that any of the critical activities, or specific milestone dates or completion dates fall behind by 14 days or more, or in the opinion of the Engineer, Owner, Owner's rep & Program / Construction Manager are in jeopardy, the Contractor shall be required to, at no extra cost to the Owner, prepare and submit to the Owner, Design Consultant and Project Expediter a supplementary Recovery Schedule, in a form and detail appropriate to the need, to explain and display how they intend to reschedule those activities to regain compliance with the Project Construction Schedule during the immediate subsequent pay period. This recovery schedule must indicate how the contractor / contractors intend to make up the delay in the project, either by additional shifts, additional work days (weekends & holidays), or by additional crews or crew sizes.

2.03 NETWORK REVISIONS

- A. Should the Contractor, after approval of the initial Project Construction Schedule, desire to change his plan of construction, he shall submit his requested revisions to the Engineer, Owner, Owner's rep & Program / Construction Manager along with a written statement of the revisions including a description of the logic for rescheduling the work, methods of maintaining adherence to intermediate milestones and Specific Dates and the reasons for the revisions. The Contractor shall revise his schedule to include the effect of Changes, acts of God or other conditions or events which have affected the network. If the requested changes are acceptable to the other Prime Contractors, the Engineer, Owner, Owner's rep & Program / Construction Manager, and they do not adversely impact any Milestone or Completion Dates, they will be incorporated into a revised Approved Project Construction Schedule, to be compiled and produced by the Project Expediter in the next reporting period. All costs associated with such revision shall be at the sole expense of the contractor.
- B. When the Owner orders changes by Change Order which have the potential to impact the Contract milestones or Specific Dates stipulated in the Contract Documents, a Revised Network will be prepared by the Contractor and provided to the Engineer, Owner, Owner's rep & Program / Construction Manager for concurrence or revision as he deems necessary.

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After the revised network has been mutually agreed upon, it will be incorporated into a revised Project Construction Schedule, to be compiled and produced by the Project Expediter. Change Order logic will affect only those activities and performance dates directly concerned. Adjustments in Scheduled intermediate Completion Dates or for the Contract as a whole will be considered only to the extent that there is insufficient remaining float to absorb these changes.

- C. Any change to the approved Project Construction Schedule must be approved in writing by the Engineer, Owner, Owner's rep & Program / Construction Manager.
- D. Neither the updating or revision of approved Project Construction Schedule nor the submission, updating, change or revision of any report or schedule submitted to Engineer, Owner, Owner's rep & Program / Construction Manager by Contractor under this Section nor Owner's review or non-objection of any such report or schedule shall have the effect of amending or modifying, in any way, the Contract Time, any Contract Completion Date, or Contract Milestone Dates or of modifying or limiting in any way Contractor's obligations under this Contract.

2.04 FLOAT TIME

- A. Float or slack time is defined as the amount of time between the earliest start date and the latest start date or between the earliest finish date and the latest finish date of a chain of activities on the Detailed Construction Network. Contractor's work shall proceed according to early start dates, and the Engineer, Owner, Owner's rep & Program / Construction Manager shall have the right to reserve and apportion float time according to the needs of the project. The Contractor acknowledges and agrees that actual delays, affecting paths of activities containing float time, will not have any effect upon contract completion times, providing that the actual delay does not exceed the float time associated with those activities.
- B. Extensions of time for performance as described in the Contract Documents will be granted only to the extent that time adjustment for the activity or activities affected by any condition or event which entitles the Contractor to a time extension exceed the total float or slack along the path of activities affected at the time of Notice to Proceed of a Change Order or the commencement of any delay or condition for which an adjustment is warranted under the Contract Documents.

2.05 REQUESTED TIME ADJUSTMENT SCHEDULE:

- A. The updated approved Project Construction Schedule submitted by Project Expediter shall not show a completion date later than the Contract Time, subject to any time extensions approved by Owner. If Contractor believes he is entitled to an extension of the Contract Time under the Contract Documents, Contractor shall submit to Owner and Design Consultant, a separate schedule analysis (entitled "Requested Time Adjustment Schedule") indicating suggested adjustments in the Contract Time which should, in the opinion of Contractor, be made in accordance with the contract Documents by time extension, due to changes, delays or conditions occurring during the past month or previously, or which are expected or contemplated by Contractor (whether such conditions are excusable under the Contract or are alleged to be due to Contractor or Owner fault); this separate schedule, if submitted, shall be time-scaled utilizing a computer generated and computer-drawn network analysis schedule, unless otherwise approved by the Engineer, Owner, Owner's rep &

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Program / Construction Manager and shall be accompanied or preceded by a formal time extension request as required by the Contract and a detailed narrative justifying the time extension requested.

- B. Neither the Engineer, Owner, Owner's rep & Program / Construction Manager shall have any obligation to consider any time extension request unless the requirements of all of the Contract Documents, are complied with the Owner shall not be responsible or liable to Contractor for any constructive acceleration due to failure of Owner to grant time extensions under the Contract Documents should Contractor fail to substantially comply with the submission requirements and the justification requirements of this Contract for time extension requests. Contractor's failure to perform in accordance with the approved Project Construction Schedule shall not be excused, nor be chargeable to Owner, because Contractor has submitted time extension requests or a "Requested Time Adjustment Schedule."

2.06 COORDINATION

- A. The Contractor shall coordinate his work with that of other contractors and shall cooperate fully with the Engineer, Owner, Owner's rep & Program / Construction Manager in maintaining orderly progress toward completion of the work as scheduled. The Engineer, Owner, Owner's rep & Program / Construction Manager decisions regarding priority between the Contractor's work and the work of other contractors at the site shall be final. If the Contractor's critical path work is delayed by the Engineer, Owner, Owner's rep & Program / Construction Manager decision, the Contractor shall submit any required time extension requests to the Owner in accordance with the Contract Documents.
- B. The milestone dates referred to in the Contract Documents for delivery of Owner-furnished equipment and materials and interface activities of other contractors on the site are based on dates set forth in separate contracts with the Owner.
- C. Failure of Owner-furnished equipment and materials to arrive as scheduled, or failure of other construction contractors to meet their schedule, shall not be justification for an extension of time, except where such failure causes, in the opinion of the Engineer, Owner, Owner's rep & Program / Construction Manager a delay in the Contractor's critical path work, in which case the provisions of the General Conditions regarding extensions of time and extra work shall apply.
- D. The Contractor shall keep himself, and his subcontractors, advised at all times during the course of the Work regarding delivery status of Owner-furnished equipment and materials and of the progress of construction work being performed under separate contracts.
- E. The Engineer, Owner, Owner's rep & Program / Construction Manager will, upon written request by the Contractor, furnish delivery information which may be available to the Engineer, Owner, Owner's rep & Program / Construction Manager.

2.07 SCHEDULE OF OFF-SITE ACTIVITIES

- A. The Contractor shall include in his Detailed Construction Network all procurement related activities which lead to the delivery of materials to the site in a timely manner. Upon written approval by the Engineer, Owner, Owner's rep & Program / Construction Manager, these

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activities may be submitted as a separate Off-Site Activities Schedule, properly correlated to the Detailed Construction Schedule. The schedule of off-site activities shall include, but is not limited to, the following:

1. Dates for submittals, ordering, manufacturing or fabricating, and delivery of equipment and materials. Long lead items requiring more than one month between ordering and delivery to site shall be clearly noted;
 2. All significant activities to be performed by the Contractor during the fabrication and erection/installation in a Contractor's plant or on a job site, including materials/equipment purchasing, delivery; and
 3. Contractor's drawings and submittals to be prepared and submitted to the Design Consultant.
- B. The Contractor shall be solely responsible for expediting the delivery of all material to be furnished by him so that the construction progress shall be maintained according to the approved Project Construction Schedule for the Work as approved by the Engineer, Owner, Owner's rep & Program / Construction Manager.
- C. The Engineer, Owner, Owner's rep & Program / Construction Manager shall be advised in writing by the Contractor whenever it is anticipated by the Contractor that the delivery date of any material and/or equipment furnished by the Contractor for installation will be later than the delivery date shown on the schedule, subject to schedule updates.
- D. Submittals, equipment orders and similar items are to be treated as schedule activities, and shall be given appropriate activity numbers.
- E. The Contractor, in developing his off-site and procurement schedules, will ensure that off-site activities do not control the critical path of on-site activities.

2.08 CONTRACTOR COVENANTS AND GUARANTEES

- A. Contractor covenants and guarantees that Contractor will not:
1. Misrepresent to Engineer, Owner, Owner's rep & Program / Construction Manager its planning scheduling or execution of the Work;
 2. Utilize schedules materially different from those made available by Contractor to the Engineer, Owner, Owner's rep & Program / Construction Manager or any Subcontractor or separate Contractors for the direction, execution and coordination of the Work, or which are not feasible or realistic.
 3. Prepare schedules, updates, revisions or reports for the work which do not accurately reflect the actual intent or reasonable and actual expectations of Contractor and its Subcontractor as to:
 - (a) The sequences of activities,
 - (b) The duration of activities,

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- (c) The responsibility of activities,
 - (d) Resources availability,
 - (e) Labor availability or efficiency,
 - (f) Foreseeable weather conditions,
 - (g) The value associated with the activity,
 - (h) The percentage complete of any activity,
 - (i) Completion of any item of work or activity,
 - (j) Project milestone completion,
 - (k) Delays, slippage's, or problems encountered or expected,
 - (l) Subcontractor requests for time extensions or delay claims of subcontractors, and
 - (m) Float time
- B. Contractor's failure to substantially comply with the foregoing covenant and guarantee shall be a substantial and material breach of contract which will permit Owner to terminate Contract for default, or withhold payments under the Contract Documents, and shall entitle Owner to the damages afforded for misrepresentation or fraud by these Contract documents or applicable law.
- C. Should Contractor fail to substantially comply with the provisions of the Contract documents relating to planning, scheduling and execution of the Work by the overall project schedule, Owner and the Design Consultant shall have the right, at their option, after five (5) days notice, to retain the services of scheduling consultants or experts (including attorneys if necessary in their opinion) to prepare a schedule in accordance with the Contract Documents and to review and analyze same, in order to allow Engineer, Owner, Owner's rep & Program / Construction Manager to evaluate the program of the Work by Contractor, to determine whether Contractor is substantially complying with the Contract Documents, and to direct such action on the part of the contractor to ensure that Contractor will meet the Project's Construction Schedule and all Milestone and Completion Dates. All costs incurred by Owner in preparing the schedule hereunder shall be charged to the responsible Contractor(s). If Contractor fails to substantially comply with the scheduling and execution of the work requirements of the Contract Documents, Contractor hereby agrees to pay all costs for a 3rd party scheduling consultant (selected by the Owner) for the development and twice monthly updating of the construction schedule.

2.09 DEFAULT

Failure of the Contractor to substantially comply with the requirements of this Section shall constitute reason that the Contractor is failing to prosecute the Work with such diligence as

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will ensure its completion within the Contract times and shall be considered grounds for termination by the Owner, pursuant to the General Conditions.

END OF SECTION 01 32 16

SUBMITTALS Section 01 33 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.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.

.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Submittal schedule.
 - 3. Shop Drawings.
 - 4. Product Data.
 - 5. Samples.
 - 6. Quality assurance submittals.
- B. Administrative Submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:
 - 1. Permits.
 - 2. Applications for Payment.
 - 3. Performance and payment bonds.
 - 4. Insurance certificates.
 - 5. List of subcontractors.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 01 Section "Applications for Payment" specifies requirements for submittal of the Schedule of Values.
 - 2. Division 01 Section "Quality Control" specifies requirements for submittal of inspection and test reports.
 - 3. Division 01 Section "Contract Closeout" specifies requirements for submittal of Project Record Documents and warranties at project closeout.

.3 DEFINITIONS

- A. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

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- B. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.

4 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 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 elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The [Architect/Engineer] reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
 - 3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
 - a. Allow 2 weeks for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.
 - b. If an intermediate submittal is necessary, process the same as the initial submittal.
 - c. Allow 2 weeks for reprocessing each submittal.
 - d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 - 1. Provide a space approximately 4 by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.
 - 2. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of the [Architect/Engineer].
 - d. Name and address of the Contractor.
 - e. Name and address of the subcontractor.
 - f. Name and address of the supplier.
 - g. Name of the manufacturer.
 - h. Spec section number & name
- C. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Engineer using a transmittal form. The Engineer will not accept submittals received from sources other than the Contractor.

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1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart-type, contractor's construction schedule. Submit within 15 days after the date established for "Commencement of the Work."
 1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values."
 2. Within each time bar, indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
 3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.
 5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Engineer's procedures necessary for certification of Substantial Completion.
- B. Distribution: Following response to the initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project meeting room and temporary field office.
 1. When revisions are made, distribute 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 construction activities.
- C. Schedule Updating: Revise the schedule after each meeting, event, or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

.6 SUBMITTAL SCHEDULE

- A. A submittal schedule is required for this project. The schedule shall be organized based upon the technical specification index for divisions 2-49 of this project.

.7 DAILY CONSTRUCTION REPORTS

- A. Prepare a weekly construction report recording the following information concerning events at the site, and submit duplicate copies to the Engineer at monthly intervals:

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1. List of subcontractors at the site.
2. Approximate count of personnel at the site.
3. High and low temperatures, general weather conditions.
4. Accidents and unusual events.
5. Meetings and significant decisions.
6. Stoppages, delays, shortages, and losses.
7. Meter readings and similar recordings.
8. Emergency procedures.
9. Orders and requests of governing authorities.
10. Change Orders received, implemented.
11. Services connected, disconnected.
12. Equipment or system tests and startups.
13. Partial Completions, occupancies.
14. Substantial Completions authorized.

.8 SHOP DRAWINGS

- A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
 1. Dimensions.
 2. Identification of products and materials included by sheet and detail number.
 3. Compliance with specified standards.
 4. Notation of coordination requirements.
 5. Notation of dimensions established by field measurement.
 6. 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 36 by 48 inches (890 by 1220 mm).
 7. Initial Submittal: Submit 2 blue- or black-line prints for the Engineer's review. The Engineer will return one print.
 8. Final Submittal: Submit 3 blue- or black-line prints and 2 additional prints where required for maintenance manuals, plus the number of prints needed by the Engineer for distribution. The Engineer will retain 2 prints and return the remainder.
 - a. One of the prints returned shall be marked up and maintained as a "Record Document."
 9. Do not use Shop Drawings without an appropriate final stamp indicating action taken.

.9 PRODUCT DATA

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- A. Collect Product Data into a single submittal for each specification section or each element of construction or system. Partial submittals will NOT BE accepted. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
 - 1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
 - a. Manufacturer's printed recommendations.
 - b. Compliance with trade association standards.
 - c. Compliance with recognized testing agency standards.
 - d. Application of testing agency labels and seals.
 - e. Notation of dimensions verified by field measurement.
 - f. Notation of coordination requirements.
 - 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
 - 3. Submittals: Submit 2 copies of each required submittal; submit 4 copies where required for maintenance manuals. The Engineer will retain one and will return the other marked with action taken and corrections or modifications required.
 - a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
 - 4. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
 - a. Do not proceed with installation until a copy of Product Data is in the Installer's possession.
 - b. Do not permit use of unmarked copies of Product Data in connection with construction.

.10 SAMPLES

- A. Samples are required as indicated in technical specification divisions 2-49 for this project.

.11 QUALITY ASSURANCE SUBMITTALS

- A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
- B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.

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1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.
- C. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

.12 ENGINEER'S ACTION

- A. Except for submittals for the record or information, where action and return is required, the Engineer will review each submittal, mark to indicate action taken, and return promptly.
 1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Report: The Engineer attach to each submittal a uniform, action summary sheet. The Engineer will mark the sheet appropriately to indicate the action taken, as follows:
 1. Final Unrestricted Release: When the Engineer marks a submittal "No Exceptions Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 2. Final-But-Restricted Release: When the Engineer marks a submittal "Note Markings," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
 3. Returned for Resubmittal: When the Engineer marks a submittal "Not Approved, Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Not Approved, Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
 4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Action Not Required."
- C. Unsolicited Submittals: The Engineer will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 33 00

SUBMITTALS

CONSTRUCTION FACILITIES Section 01 52 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

1.1 Related Documents

- A. The General Conditions of the Contract apply to this section.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.2 Summary

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Temporary utilities required include, but are not limited to:
 - 1. Water service and distribution.
 - 2. Temporary electric power and light.
- C. Temporary construction and support facilities required include, but are not limited to:
 - 1. Temporary enclosures.
 - 2. Temporary Project identification signs
 - 3. Construction aids and miscellaneous services and facilities.
- D. Security and protection facilities required include, but are not limited to:
 - 1. Temporary fire protection.
 - 2. Barricades, warning signs, lights.
 - 3. Sidewalk bridge or enclosure fence for the site.
 - 4. Environmental protection.
- E. The responsibility to install, maintain, and remove this Work shall be the General Contractor's. Temporary facilities provided by the Contractor include, but are not necessarily limited to:
 - Temporary enclosures
 - Temporary Project identification signs and bulletin boards
 - Waste collection and disposal services
 - Construction aids and miscellaneous services and facilities
 - Temporary fire protection
 - Barricades, warning signs, lights.
 - Sidewalk bridge or enclosure fence for the site.
 - Environmental protection.
 - Protection of stored materials

1.3 Definitions

- A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weather-tight; exterior walls are insulated and weather-tight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 Use Charges

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Sewer can be used at no cost to the Contractor.
- C. Water Service: Water can be used at no cost to the Contractor.
- D. Electric Power Service: Power can be used at no cost to the Contractor.

CONSTRUCTION FACILITIES

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1.5 Quality Assurance

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including but not limited to:
 - 1. Building Code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department and Rescue Squad rules.
 - 5. Environmental protection regulations.
- B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations"; ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities".
 - 1. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services", prepared jointly by AGC and ASC for industry recommendations.
 - 2. Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electrical service. Install services in compliance with National Electric Code and NFPA 70.
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.1 Materials

- A. General: Provide new materials suitable for the use intended; if acceptable to the Architect, undamaged previously used materials in serviceable condition may be used.

2.2 Temporary Facilities

- A. General: Provide equipment suitable for the use intended; if acceptable to the Architect, undamaged, previously used equipment in serviceable condition may be used.
- B. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical aerated re-circulating type, properly vented and fully enclosed with a glass fiber reinforced polyester shell or similar nonabsorbent material. Include temporary toilets, wash facilities and drinking water fixtures. Comply with regulations and health codes for the type, number, location, operation and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.

PART 3 - EXECUTION

3.1 Installation, General

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed, or are replaced by authorized use of completed permanent facilities.
- C. The cost for installation, maintenance, removal or use of temporary facilities and utilities are not chargeable to the Owner or Architect and will not be accepted as a basis of claims for a Change Order.
- D. All temporary utilities' operational expenses shall be borne by the General Contractor, unless otherwise indicated.

CONSTRUCTION FACILITIES **Section 01 52 00**

3.2 Security and Protection Facilities Installation

- A. Do not change over from use of temporary security and protection facilities to permanent facilities until Substantial completion, or longer as requested by the Architect.
- B. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft and similar violations of security. Where materials and equipment must be stored and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- C. Protection Of Installed Work
 - 1. Protect installed work and provide special protection where specified in individual specification Sections.
 - 2. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.
 - 3. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
 - 4. Protect, with durable sheet materials, finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.
 - 5. Prohibit traffic on landscaped areas.

3.3 Operation, Termination and Removal

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by adverse weather conditions.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation and similar facilities on a 24-hour day basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. Prevent water filled piping from freezing.
 - 3. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Unless the Engineer requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or not later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired.

END OF SECTION 01 52 00

CLOSEOUT PROCEDURES Section 01 77 00

Clayton Middle School AHU 16 and 17 Replacement

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. Project Record Documents.
 - 3. Operation and maintenance manuals.
 - 4. Warranties.
 - 5. Instruction of Johnston County Public School's personnel.
 - 6. Final cleaning.
- B. Specific requirements of each contract are also indicated in individual Specification Sections, All Bid Documents and on Drawings.

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. GC to 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 Johnston County Public Schools 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 Johnston County Public Schools unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Johnston County Public Schools. Label with manufacturer's name and model number where applicable.

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7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer, Owner, Owner's Rep or Program / Construction Manager 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, Owner, Owner's Rep or Program / Construction Manager, that must be completed or corrected before certificate will be issued.
 1. Re-inspection: Request re-inspection 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 1 Section "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. Final Completion must be achieved within 30 calendar days of Substantial Completion.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer, Owner, Owner's Rep or Program / Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will accept for review, 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.
- B. Organize list of spaces in sequential order.

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1. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
2. 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 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer, Owner, Owner's Rep or Program / Construction Manager reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
 1. 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 cannot be readily identified and recorded 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.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
 6. Provide a spreadsheet inventory list of all filters, sizes, locations, etc. prior to Substantial Completion.

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- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy 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. Note related Change Orders, Record Drawings, and Product Data, where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
 - 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 Drawings, and Record Specifications, where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.7 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. Partial Occupancy: Submit properly executed warranties within 15 working days of completion of designated portions of the Work that are completed and occupied or used by Johnston County Public Schools during construction period.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual. Utilize the format of the attached Warranty and Closeout index at the end of section 01 78 36 Warranties.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy duty dividers with pre-numbered plastic coated tabs for each separate warranty. Provide a typed description of the product or installation on the index (see example at the end of this section). Include the spec section number, name of the product, and the name, address, and telephone number of the Installer on the Contractor and Supplier List at the front of the warranty binder.

CLOSEOUT PROCEDURES Section 01 77 00

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project title or name, and name of the Contractor. Use the spine & cover sheet examples at the end of this section as templates.
 4. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.
- D. Provide letter certifying that no materials containing asbestos or lead have been used in the construction of this project.
- E. Provide 1 hard copies, and 1 electronic copy in Portable Document Format (PDF), of all closeout documents to Engineer for distribution to Owner. This includes O & M Manuals, Project Documents, As-Built Drawings, Approvals, Certificates, and all warranty information. PDF is to be verified as fully searchable and Indexed by spec section number, or by plan section and page number for drawings, and the index shall be fully linked with the document pages.

1.8 O & M BINDERS

1. Bind O & M Data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual. Utilize the format of the attached O & M index at the end of this section.
2. Provide heavy duty dividers with pre-numbered plastic coated tabs for each separate Maintenance Manual. Provide a typed description of the product or installation on the index (see example at the end of this section). Include the spec section number, name of the product, and the name, address, and telephone number of the Installer on the Contractor and Supplier List at the front of the O & M binder.
3. Identify each binder on the front and spine with the typed or printed title "Operations & Maintenance," Project title or name, and name of the Contractor. Use the spine & cover sheet examples at the end of this section as templates.
4. Provide additional copies of each required warranty, as necessary, for inclusion in each related section of O & M Binder.

1.9 O & M Manuals Digital

- A. Assemble one (1) digital set of operations and maintenance data indicating the operation and maintenance of each piece of equipment... Include operation and maintenance data required in individual Specification Sections and as follows:
1. Maintenance Data:
 - a. Manufacturers information, including list of spare parts
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds
- B. Organize operation and maintenance manuals per Section 1.10 Closeout Document Organization.

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- C. Operation and Maintenance manuals must have operation and maintenance instructions. Submittals are not acceptable replacements for operation and maintenance instructions. If submittals are submitted instead of O&M information the manuals will not be reviewed and will be rejected. Operation and Maintenance manuals **must also contain** copies of approved **Submittal Product Data and Shop Drawings**
- D. Please make sure the following conditions are adhered to:
1. All warranties must be made out to the owner, (i.e. Johnston County Public Schools) and contain the project name and address.
 2. All warranties must have proof of authenticity. Contractor and installer warranties must be signed originals specifying project, owner and warranty period commencing from the date of substantial completion. The document can state “from substantial completion” or give the actual Engineer certified date. Either of the following is considered acceptable for manufacturers’ warranties: An original manufacturer warranty with name of project, owner and date of substantial completion, a manufacturer warranty accompanied by an original letter from the manufacturer bearing original or electronic signatures of manufacturer, certifying the authenticity of the manufacturer’s standard warranty naming project, school, and date of substantial completion; a manufacturer’s warranty accompanied by a manufacturer’s agent original signed letter certifying the authenticity and naming project, owner and date of substantial completion. A manufacturer’s agent certification will only be considered acceptable if it is accompanied by a signed letter from the manufacturer verifying the agent has Power of Attorney or specific authority to authenticate the manufacturer’s warranty as “project specific”.
 3. Check that warranties include labor where specified.
 4. The Prime contractor’s corporate seal (if a corporation) is required on section 00 65 23 warranty.
 5. The commencement date for all warranties is the date of substantial completion. This date shall be listed on the warranty or shall say “from the date of declared substantial completion”. A manufacturer’s warranty on equipment shall always cover the gap from early start up to the date of substantial completion. This is a part of the contract and a cost of the work.
 6. Warranties cannot contain conditional clauses (such as “this warranty is not or shall not become effective until the contractor has been paid in full”).
 7. **A separate training letter and associated sign in sheet are required for each owner training session.** A list of required training sessions will be included in the warranty closeout document binder.
 8. Stock Materials shall be transported to the JCPS Maintenance Department at 601 West Market Street, Smithfield, NC, or other location designated by Johnston County Public

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Schools. A copy of the signed transmittal showing delivery of stock materials took place is to be included in the warranty closeout binder.

9. An As-Built Survey showing “line and grade” is required to be submitted and approved by the civil engineer for all site work, site utilities and buildings installed under this contract.
10. All keys listed below shall be turned over to the owner in one submission package accompanied by a signed itemized transmittal identifying the contents of the submission. A copy of the signed transmittal is to be included in the warranty closeout binder along with the hardware suppliers “key letter” sent to the owner under separate cover when the door hardware keys were sent.
 - a. Door hardware keys in a key box (sent directly to JCPS by the hardware supplier with separate transmittals)
 - b. Kitchen equipment keys
 - c. Walk-in cooler & freezer keys
 - d. Roll up door & grill keys
 - e. Elevator keys
 - f. Electrical panel keys – two (2) per panel
 - g. HVAC controls panel keys
 - h. Fire alarm panel keys - two (2) per panel
 - i. Security alarm panel keys
 - j. Sound system cabinet keys
 - k. Hose bib / wall hydrant keys - two (2) per hose bib / wall / hydrant
 - l. Classroom teacher’s cabinet keys – two (2) per lockable cabinet
 - m. Generator Keys
 - n. Press Box / Announcer’s Box Keys – 2 minimum
 - o. Fire Alarm Device Keys – two (2) per device
 - p. Access Panel door keys

1.10 CLOSEOUT DOCUMENTATION ORGANIZATION

A. Instructions for Closeout Binders

1. JCPS will provide a Pdf or Microsoft Word and Excel files to the contractor for each project with the format information for the three ringed **Warranty Binders and O & M Binders**. The Prime contractor(s) will prepare (1) identical Warranty/Closeout binders and (1) identical sets of O&M binders with original documents in each binder.

There will be a **minimum of 1 binder total** (1 each for Warranty / Closeout and 1 each for O&M with original documents) submit one (1) to the Engineer for review and forwarded to GCS if acceptable. The fourth copy of the binders is to be kept by the contractor as a back-up set, in case the originals are lost in transit between offices.

A table of contents and corresponding numbered divider tabs will be included and MUST be utilized to identify and separate the contents. If the table of contents and numbered tabs are not utilized, the manuals will not be reviewed and will be rejected.

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2. The Warranty and O&M table of contents was taken directly from the Specifications, if any of the items listed do not apply (have been deleted/changed by change order **insert an “exception sheet” behind the corresponding numbered tab** (samples attached) with the following information:
 - a. Item that was changed, deleted or not required with a signature block for the contractor.

Note: DO NOT leave a blank space behind a tab. If the information is located somewhere else put a copy of it behind the appropriate tab or put a sheet behind the tab stating exactly where the information is located (i.e. “Product data is included on the shop drawing.”).

3. Operation and Maintenance manuals must have operation and maintenance instructions. Submittals are not acceptable replacements for operation and maintenance instructions. If submittals are submitted instead of O&M information the manuals will not be reviewed and will be rejected. Operation and Maintenance manuals **must also contain** copies of approved **Submittal Product Data and Shop Drawings. Shop Drawings should be numbered with the appropriate spec section number, compiled in spec section order and submitted as a rolled up drawing set with the O & M manuals. Small format shop drawings (i.e. 11 X 17 and smaller) should be 3-hole punched and placed in the O&M binder behind the appropriate tab.**

Where multiple O & M Binders are required to complete a single set, indicate the Volume # of the set # (IE. Volume 1 of 2), and the Tab #s included in each binder (IE. Tabs 1 thru 25).

The Engineer is to ensure that there are no blank tabs in the binders before forwarding them to GCS.

4. Provide following information on the cover and spine of each manual:

Name of School or Project

Name of the Manual, i.e., **Warranty & Closeout Manual** or **O&M Manual**.

Contractor’s Name

Contract Type i.e. **General Prime Contract** (if multi-prime project) or **Single Prime Contract**

Name of Engineer/Engineer

Date of substantial completion

Volume of

Tabs Thru

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B. Instructions for Digital Closeouts

All closeout documentation shall be submitted in electronic format unless noted otherwise. The information is to be organized using Window Explorer folder system as outlined below:

1. Folder #1 titled “Certificates and Approvals”
 - a. Project Contact List (all participants including contractors, subcontractors, suppliers, etc.)
 - b. Letters from contractor requesting substantial and final inspections
 - c. Certificate of Occupancy by local AHJ
 - d. Required approvals from other agencies
 - e. Certificate of Substantial Completion
 - f. Certificate of Final Completion
 - g. Punchlist(s)
 - h. Contractor letter stating no asbestos-containing materials were used in the construction of the project.
 - i. Any other documentation requested by the owner.
2. Folder #2 titled “Warranty Manual”
 - a. Contractor’s General Warranty
 - b. Manufacturers / Installer / Equipment and System Warranties
3. Folder #3 titled “Submittal Documents”
 - a. All final approved shop drawings submittals organized in CSI Masterformat
 - b. Documentation of all manufacturer / material color and finish selections (by schedule or location)
4. Folder #4 titled “O&M Manual”: Requirements are outlined in the Project Manual
5. Folder #5 titled “Record Drawings and Project Manual”
 - a. PDF files of all final drawings
 - b. PDF of Project Manual
 - c. Electronic CAD files of all drawings in format acceptable to the Owner

CLOSEOUT PROCEDURES Section 01 77 00

- d. PDF of Bid Addendum
- e. Scanned PDF set of field marked up as-built drawings.

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. Final Cleaning is the responsibility of the General Contractor. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits
 - .
 - b. Pressure wash all concrete and paved surfaces.
 - 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 for safe access to facility. Continue providing this service until substantial completion has been achieved.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults / closets, manholes, attics, mezzanines and similar spaces.

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- g. Sweep concrete floors broom clean with sweeping compound.
 - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; have carpets professionally shampooed / cleaned if visible soil or stains remain.
 - i. 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 materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. 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.
 - l. Remove any paint from "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment and similar equipment. Remove excess lubrication, paint and mortar drippings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of all diffusers, registers and grilles.
 - q. Clean ducts, blowers and coils.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned out bulbs, and those noticeably dimmed by hours of use, and defective and / or noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. GC to be responsible for professional final cleaning of the interior of the building to include six (6) coats of wax on all VCT or hard surface flooring.
 - t. All fixtures to be wiped clean. Food Service equipment to be cleaned. The GC warrants that it will provide the facility in a "white glove test" condition to the Owner.
 - u. GC to be responsible for final cleaning of building exterior to include windows and all horizontal and vertical surfaces.
 - v. GC to pressure wash all exterior hard surfaces.
 - w. GC to provide the same cleaning as listed herein for adjacent spaces that have been effected by the construction process.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Johnston County Public Schools' property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.
- D. Pest Control: Engage an experience, licensed exterminator to make a final inspection and rid Project of any rodents, insects, and other pests. Exterminator to provide a written report to Owner prior to Substantial Completion being awarded.

CLOSEOUT PROCEDURES

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- E. The following quantities of extra materials are part of the project base bid and shall be turned over to the owner at the end of the project. Additional items listed in various specification sections are also required to be turned over to the owner at the end of the project.

Spare Parts
Extra Stock Materials –To Owner at Project Completion

Guidelines Section	Title	EXTRA STOCK

END OF SECTION 01 77 00

Closeout Requirements Section 01 77 19

Clayton Middle School AHU 16 and 17 Replacement

Substantial Completion Date:

The following documents must be completed and submitted by each prime contractor. Documents shall be submitted to the Architect in a single package with this (completed) checklist attached. The Architect must receive all documents before the Contractor's Final Application for Payment can be reviewed.

- _____ 1. *Final Application for Payment (with Continuation Sheets & Tax Reports)
- _____ 2. *Executed Certificate of substantial Completion with punch list attached.
- _____ 3. *Contractor's Affidavit of Payment of Debts and Claims (fully executed – AIA Form G706)
- _____ 4. *Contractor's Affidavit of Release of Liens (fully executed – AIA Form G 706A)
- _____ 5. *Release of liens by subcontractors and/or vendors (fully executed – when required)
- _____ 6. *Consent of Surety to Final Payment (AIA G707)
- _____ 7. Certificate of Occupancy from proper municipality
- _____ 8. Contractor's One-Year Warranty (notarized)
- _____ 9. Warranty summary sheet and original warranties for specific items (roof, motors, etc.)
- _____ 10. Certification letter from Contractor stating that no asbestos containing materials were used.
- _____ 11. Final list of all subcontractors with names, addresses, and phone numbers
- _____ 12. Record Drawings and cover letter indicating that they have been reviewed and are as accurate and complete as possible.
- _____ 13. Certified Testing and Balancing Report for HVAC System with cover letter indicating it has been reviewed and approved by consulting Engineer.

*** Provide directly to Architect (Attn: Director of Bidding and Contract Services). Do not include in O&M manuals.**

All remaining items shall be directed to the Architect's Construction Administrator.

Contractor's Signature

Date

Architect/Engineer's Signature

Date

JCPS Close-out Manager's Signature

Date

WARRANTIES

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Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 SUMMARY

- A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers' standard warranties on products and special warranties.
 - 1. Refer to the General Conditions for terms of the Contractor's period for correction of the Work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 01 Section "Submittals" specifies procedures for submitting warranties.
 - 2. Division 01 Section "Closeout Procedures" specifies contract closeout procedures.
 - 3. Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.
 - 4. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

.3 DEFINITIONS

- A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

.4 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

WARRANTIES

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- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
- E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the Owner reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

.5 SUBMITTALS

- A. Submit written warranties in Portable Document Format (PDF) to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer. Note that the warranty period does not commence until Certificate of Substantial Completion has been issued for the project.
 - 1. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within 15 days of completion of that designated portion of the Work.
- B. When the Contract Documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner, through the Engineer, for approval prior to final execution.
 - 1. Refer to Divisions 2 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.

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2. Provide 1 hard copies, and 1 electronic copy in Portable Document Format (PDF), of all closeout documents to Engineer for distribution to Owner. This includes O & M Manuals, Project Documents, As-Built Drawings, Approvals, Certificates, and all warranty information. PDF is to be verified as fully searchable and Indexed by spec section number, or by plan section and page number for drawings, and the index shall be fully linked with the document pages.

.6 O & M BINDERS

1. Bind O & M Data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual. Utilize the format of the attached O & M index at the end of this section.
2. Provide heavy duty dividers with pre-numbered plastic coated tabs for each separate Maintenance Manual. Provide a typed description of the product or installation on the index (see example at the end of this section). Include the spec section number, name of the product, and the name, address, and telephone number of the Installer on the Contractor and Supplier List at the front of the O & M binder.
3. Identify each binder on the front and spine with the typed or printed title "Operations & Maintenance," Project title or name, and name of the Contractor. Use the spine & cover sheet examples at the end of this section as templates.
4. Provide additional copies of each required warranty, as necessary, for inclusion in each related section of O & M Binder.

.7 O & M Manuals Digital

- A. Assemble one (1) digital set of operations and maintenance data indicating the operation and maintenance of each piece of equipment... Include operation and maintenance data required in individual Specification Sections and as follows:
 1. Maintenance Data:
 - a. Manufacturers information, including list of spare parts
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds
- B. Organize operation and maintenance manuals per Section 1.10 Closeout Document Organization.
- C. Operation and Maintenance manuals must have operation and maintenance instructions. Submittals are not acceptable replacements for operation and maintenance instructions. If submittals are submitted instead of O&M information the manuals will not be reviewed and will be rejected. Operation and Maintenance manuals **must also contain** copies of approved **Submittal Product Data and Shop Drawings**.

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D. Please make sure the following conditions are adhered to:

1. All warranties must be made out to the owner, (i.e. Johnston County Public Schools) and contain the project name and address.
2. All warranties must have proof of authenticity. Contractor and installer warranties must be signed originals specifying project, owner and warranty period commencing from the date of substantial completion. The document can state “from substantial completion” or give the actual Engineer certified date. Either of the following is considered acceptable for manufacturers’ warranties: An original manufacturer warranty with name of project, owner and date of substantial completion, a manufacturer warranty accompanied by an original letter from the manufacturer bearing original or electronic signatures of manufacturer, certifying the authenticity of the manufacturer’s standard warranty naming project, school, and date of substantial completion; a manufacturer’s warranty accompanied by a manufacturer’s agent original signed letter certifying the authenticity and naming project, owner and date of substantial completion. A manufacturer’s agent certification will only be considered acceptable if it is accompanied by a signed letter from the manufacturer verifying the agent has Power of Attorney or specific authority to authenticate the manufacturer’s warranty as “project specific”.
3. Check that warranties include labor where specified.
4. The Prime contractor’s corporate seal (if a corporation) is required on contractor’s general warranty.
5. The commencement date for all warranties is the date of substantial completion. This date shall be listed on the warranty or shall say “from the date of declared substantial completion”. A manufacturer’s warranty on equipment shall always cover the gap from early start up to the date of substantial completion. This is a part of the contract and a cost of the work.
6. Warranties cannot contain conditional clauses (such as “this warranty is not or shall not become effective until the contractor has been paid in full”).
7. **A separate training letter and associated sign in sheet are required for each owner training session.** A list of required training sessions will be included in the warranty closeout document binder.
8. Stock Materials shall be transported to the JCPS Maintenance Department at 601 West Market Street, Smithfield, NC, or other location designated by Johnston County Public Schools. A copy of the signed transmittal showing delivery of stock materials took place is to be included in the warranty closeout binder.
9. An As-Built Survey showing “line and grade” is required to be submitted and approved by the civil engineer for all site work, site utilities and buildings installed under this contract.

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10. All keys listed below shall be turned over to the owner in one submission package accompanied by a signed itemized transmittal identifying the contents of the submission. A copy of the signed transmittal is to be included in the warranty closeout binder along with the hardware suppliers "key letter" sent to the owner under separate cover when the door hardware keys were sent.
 - a. Electrical panel keys – two (2) per panel
 - b. Fire alarm panel keys - two (2) per panel
 - c. Fire Alarm Device Keys – two (2) per device
 - d. Access Panel door keys

.8 CLOSEOUT DOCUMENTATION ORGANIZATION

A. Instructions for Closeout Binders

1. JCPS will provide a Pdf or Microsoft Word and Excel files to the contractor for each project with the format information for the three ringed **Warranty Binders and O & M Binders**. The Prime contractor(s) will prepare (1) identical Warranty/Closeout binders and (1) identical sets of O&M binders with original documents in each binder.

There will be a **minimum of 1 binder total** (1 each for Warranty / Closeout and 1 each for O&M with original documents) submit one (1) to the Engineer for review and forwarded to GCS if acceptable. The fourth copy of the binders is to be kept by the contractor as a back-up set, in case the originals are lost in transit between offices.

A table of contents and corresponding numbered divider tabs will be included and MUST be utilized to identify and separate the contents. If the table of contents and numbered tabs are not utilized, the manuals will not be reviewed and will be rejected.

2. The Warranty and O&M table of contents was taken directly from the Specifications, if any of the items listed do not apply (have been deleted/changed by change order **insert an "exception sheet" behind the corresponding numbered tab** (samples attached) with the following information:

- a. Item that was changed, deleted or not required with a signature block for the contractor.

Note: DO NOT leave a blank space behind a tab. If the information is located somewhere else put a copy of it behind the appropriate tab or put a sheet behind the tab stating exactly where the information is located (i.e. "Product data is included on the shop drawing.").

3. Operation and Maintenance manuals must have operation and maintenance instructions. Submittals are not acceptable replacements for operation and maintenance instructions. If submittals are submitted instead of O&M information the manuals will not be reviewed and will be rejected. Operation and Maintenance manuals **must also contain** copies of approved **Submittal Product Data and Shop Drawings. Shop Drawings should be numbered with the appropriate spec section number, compiled in spec section order**

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and submitted as a rolled up drawing set with the O & M manuals. Small format shop drawings (i.e. 11 X 17 and smaller) should be 3-hole punched and placed in the O&M binder behind the appropriate tab.

Where multiple O & M Binders are required to complete a single set, indicate the Volume # of the set # (IE. Volume 1 of 2), and the Tab #s included in each binder (IE. Tabs 1 thru 25).

The Engineer is to ensure that there are no blank tabs in the binders before forwarding them to GCS.

4. Provide following information on the cover and spine of each manual:

Name of School or Project

Name of the Manual, i.e., **Warranty & Closeout Manual** or **O&M Manual**.

Contractor's Name

Contract Type i.e. **General Prime Contract (if multi-prime project) or Single Prime Contract**

Name of Engineer/Engineer

Date of substantial completion

Volume _____ of _____

Tabs _____ Thru _____

B. Instructions for Digital Closeouts

All closeout documentation shall be submitted in electronic format unless noted otherwise. The information is to be organized using Window Explorer folder system as outlined below:

1. Folder #1 titled "Certificates and Approvals"
 - a. Project Contact List (all participants including contractors, subcontractors, suppliers, etc.)
 - b. Letters from contractor requesting substantial and final inspections
 - c. Certificate of Occupancy by local AHJ
 - d. Required approvals from other agencies
 - e. Certificate of Substantial Completion
 - f. Certificate of Final Completion
 - g. Punchlist(s)

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- h. Contractor letter stating no asbestos-containing materials were used in the construction of the project.
 - i. Any other documentation requested by the owner.
- 2. Folder #2 titled "Warranty Manual"
 - a. Contractor's General Warranty
 - b. Manufacturers / Installer / Equipment and System Warranties
- 3. Folder #3 titled "Submittal Documents"
 - a. All final approved shop drawings submittals organized in CSI Masterformat
 - b. Documentation of all manufacturer / material color and finish selections (by schedule or location)
- 4. Folder #4 titled "O&M Manual": Requirements are outlined in the Project Manual
- 5. Folder #5 titled "Record Drawings and Project Manual"
 - a. PDF files of all final drawings
 - b. PDF of Project Manual
 - c. Electronic CAD files of all drawings in format acceptable to the Owner
 - d. PDF of Bid Addendum
 - e. Scanned PDF set of field marked up as-built drawings.

Exception to Contract Documents

For use when a work item identified in the JCPS provided Warranty and O&M Binders are deleted from the project or changed and recorded by change order.

Name of Project: _____

Specification Section: _____

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- ☐ The product data and submittal information
- ☐ O&M Manuals;
- ☐ Warranty;
- ☐ Shop Drawings were not required for this specification section as a result of a change order:

_____ dated _____.

Name,
Project Manager, (Company Name)
Contractor

Name
Construction Administrator, (Company Name)
Architect

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 78 36

DEMONSTRATION AND TRAINING Section 01 79 00

Clayton Middle School AHU 16 and 17 Replacement

PART 1 - GENERAL

1.1 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 videotapes.

1.2 Coordination

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

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. Fire-protection systems, including fire alarm, and fire protection system.
 - 2. Electrical service and distribution, including transformers, switchboards, panel boards, and motor controls.
- 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.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project Record Documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.

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- f. Special operating instructions and procedures.
- 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 Preparation

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.
- B. Set up instructional equipment at instruction location.
- C. Provide copies of sign-in sheets for all training sessions.

DEMONSTRATION AND TRAINING **Section 01 79 00**

3.2 Instruction

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- C. Demonstration and Training: During instruction, start and demonstrate each piece of equipment, not just each type of equipment, to ensure proper operation and working condition of equipment.
- 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.
- E. Video each training session and provide 3 copies of each video to the owner for their reference and use.

END OF SECTION 01 79 00

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SECTION 23 01 00 – HVAC GENERAL WORK REQUIREMENTS

PART 1 - GENERAL

1.1. SUMMARY

- A. This section includes general requirements and information for Division 23 work.

1.2. DEFINITIONS

- A. Owner Acceptance for Beneficial Occupancy: Work that is judged by the Engineer to be substantially complete, accepted to be safe for use by the Authority Having Jurisdiction (AHJ), and accepted by the Owner. Acceptance comes with an agreement the Engineer's written punchlist of outstanding items will be completed to fulfill the contractual obligations.
- B. Full Owner Occupancy: Owner will occupy the site and existing building during entire construction period.
- C. Partial Owner Occupancy: Owner may occupy completed areas of building before Owner Acceptance.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- E. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- F. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- H. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- I. Provide: Contractor shall furnish and install materials, equipment or fixtures as indicated.
- J. Install Items Furnished by Owner or Others: Contractor shall receive shipment, store, install and verify materials, equipment or fixtures selected and purchased outside of the prime construction contract as indicated.
- K. Furnish Items to Owner or Others: Contractor shall purchase and deliver materials, equipment or fixtures for installation by others as indicated.

1.3. SUBMITTALS

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- A. Qualification Submittals:
 - 1. Welding certificates.
- B. Product Submittals:
 - 1. Wall and ceiling access door product information.
- C. Construction Submittals:
 - 1. Manufacturer startup, operation and maintenance checklists for all equipment and devices included in Division 23 specifications in a single submittal package for review prior to equipment startup.
- D. Closeout Submittals:
 - 1. Manufacturer startup, operation and maintenance reports with completed checklists signed by the involved technicians and the Mechanical Contractor's witnessing superintendent.

1.4. INSPECTIONS

- A. Contractor shall be responsible for obtaining all inspections from regulatory agencies having jurisdiction over the project. These inspections include but are not limited to: NC Department of Labor Boiler Safety Bureau for boilers and pressure vessels, NC Department of Insurance, and other Local, State, and Federal inspection authorities as applicable.
- B. Contractor shall be responsible for obtaining all inspections from regulatory agencies having jurisdiction over the project. These inspections include but are not limited to: NC Department of Labor - NCDOL Boiler Safety Bureau for boilers and pressure vessels, NC Department of Insurance NCDOL, NC State Construction Office NCSCO, and other Local, State, and Federal inspection authorities as applicable.

1.5. QUALITY ASSURANCE

- A. Welding Qualifications:
 - 1. Installer Qualifications: Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
 - 2. AWS D1.1, "Structural Welding Code--Steel."
 - 3. AWS D1.2, "Structural Welding Code--Aluminum."
 - 4. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 5. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 6. ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Roof Warranties: All work on roofs shall comply with the roof manufacturer's warranty requirements. For work on existing roofs, obtain a copy of the owner's roof warranty prior to the start of work.

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- C. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- D. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- E. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.6. WARRANTY

- A. Project Warranty: All work performed and all materials installed in Division 23 shall be warrantied by the Contractor for 1 year from the Owner's written acceptance of Owner Acceptance. The warranty shall include all labor and parts. The Contractor shall be on site within 48 hours of Owner notifications.
 - 1. This warranty does not waive the Owner's obligation to provide routine maintenance. Routine maintenance includes maintenance recommended by each equipment manufacturer and industry standard requirements for overall systems as documented in the project's Operation and Maintenance Manuals. Replacement of wear items such as filters, belts, etc. are not included in the warranty unless they are incidental to other warranty work being performed. Failures due to the lack of routine maintenance are the responsibility of the Owner.
 - 2. Equipment manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the obligations of the Project Warranty.
 - 3. Extended or special warranties defined in other sections shall be in addition to, and run concurrently with, the Project Warranty.

1.7. PROJECT DOCUMENTS

- A. Project Documents: Division 23 project documents are diagrammatic in nature and intended to represent complete and functioning systems. If any aspect of the work is undefined or unclear, submit your questions in writing prior to the final addendum deadline as defined in the specifications and/or at the pre-bid conference. If any aspect of the work is undefined or unclear after the final addendum, include the cost for the highest quality solution. The contractor is encouraged to thoroughly review the contract documents and site conditions prior to bidding.
- B. Basis of Design Manufacturers: Manufacturer names and model numbers of equipment and devices noted on drawings and in equipment schedules shall be considered the Engineer's basis of design. Proposed changes to the basis of design shall be submitted to the Engineer for review and approval. The submittal shall include a description of all changes necessary to implement the substitution, including but not limited to plumbing, mechanical and electrical connections; dimensions, weights and structural supporting structure; layout changes necessary to maintain clearances; and acoustical treatments. All changes required to implement a substitution is the responsibility of Contractor at no added cost to the Owner.

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- C. Listed Manufacturers: Manufacturers listed in the Division 23 specification sections and on drawings must meet all the requirements of the project documents. Listed manufacturers that do not meet the requirements will not be accepted. The manufacturer listing does not result in an automatic approval. In addition to construction and performance requirements, the proposed equipment must meet the indicated physical dimension, weight, acoustic, power, controls, and plumbing limitations of the project. Verify existing conditions in the field, when applicable, and proposed conditions prior to submitting equipment for Engineer review. When full project coordination drawings are not required, generate coordination drawings to the level of detail necessary to determine if the proposed equipment will comply with the project documents and manufacturer recommended maintenance clearances.
 - 1. If a manufacturer's equipment does not meet the physical dimension, weight, acoustic, power, controls and plumbing limitations of the project, a change order proposal may be submitted for the Owner's and Engineer's consideration. The proposal shall include all changes, including other trades, required and a reduction in cost to accept the non-conforming equipment. The base bid shall include equipment that fully meets the design requirements at no additional cost.

1.8. COMMISSIONING PROCESS

- A. General: The Owner's Commissioning Agent (CxA) will lead a commissioning team made up of owner and contractor representatives. Refer to Section 019113 for more information.
 - 1. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
 - 2. Owner's 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.
 - 3. Owner's Facility Representatives: Facility user and operation and maintenance personnel.
 - 4. Engineers: Design professional.
- B. Contractor's Responsibilities:
 - 1. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
 - a. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 - b. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
 - c. Attend commissioning team meetings held on a weekly basis.

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- d. Integrate and coordinate commissioning process activities with construction schedule.
 - e. Review and accept construction checklists provided by the CxA.
 - f. Complete construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
 - g. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 - h. Complete commissioning process test procedures.
- C. CxA's Responsibilities:
- 1. Organize and lead the commissioning team.
 - 2. Provide commissioning plan.
 - 3. Convene commissioning team meetings.
 - 4. Provide Project-specific construction checklists and commissioning process test procedures.
 - 5. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.
 - 6. Prepare and maintain the Issues Log.
 - 7. Prepare and maintain completed construction checklist log.
 - 8. Witness systems, assemblies, equipment, and component startup.
 - 9. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

1.9. COORDINATION

- A. **Maintenance Access:** Install equipment and devices in such a manner to be readily accessible for testing, adjusting, balancing, inspection and maintenance. All concealed equipment and devices, including but not limited to equipment, valves, dampers, actuators, sensors, gauges, test ports, filter housings, coils, etc., shall be installed above accessible ceilings, within accessible rooms or chases or within normally inaccessible construction with access doors. All access doors are not shown in the project drawings. All access doors shall be coordinated with the Engineer prior to the installation of the equipment or device. Equipment and/or devices not coordinated prior to installation, as judged by the Engineer, shall be removed and reinstalled at no added cost.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

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- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

1.10. SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified Special Inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner as indicated in the Statement of Special Inspections.
- B. Special Inspector: The Special Inspector's scope of work will be defined by the Owner. In general they will verify the materials have been installed properly and completely; notify the Owner, Engineer and Contractor of deficiencies; test corrected work, and submit a certified report of their procedures and findings.
 - 1. Coordinate observations and testing with the Special Inspector and correct noted deficiencies.
- C. Mechanical System Special Inspections:
 - 1. Seismic resistance components in Section 230548.
 - 2. Wind resistance components in Section 230548.
 - 3. Firestopping systems in Section 230500.
 - 4. Smoke controls systems.

1.11. VOC CONTENTS

- A. Low Volatile Organic Compounds (VOC) Requirements: All adhesives, mastics, sealants and compounds factory or field applied that are installed indoors and all paint field applied shall be certified as low VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Adhesives: 50 g/L or less, except 80 g/L or less for calcium silicate and mineral fiber insulation and 30 g/L or less for metal-to-metal adhesives.
 - 2. Mastics: 50 g/L or less.
 - 3. Sealants: 250 g/L or less for duct sealants and 420 g/L or less for equipment insulation joint sealants.
 - 4. Compounds: 490 g/L or less for CPVC welding compounds and 510 g/L or less for PVC welding compounds.
 - 5. Paints: 50 g/L or less for flat paints and primers and 150 g/L or less for non-flat paints.

PART 2 - PRODUCTS

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2.1. PAINTS AND PRIMERS

- A. General: Provide primers and paints designed for the intended applications. All primers and paints used indoors shall be low-odor and low VOC content type.
- B. Primers:
 - 1. Metal Applications: Water-based rust-inhibitive primer.
 - 2. Aluminum Applications: Quick-drying primer for aluminum.
 - 3. Wood Applications: Latex-based wood primer.
 - 4. Interior Applications: Interior latex primer/sealer.
- C. Paints:
 - 1. Interior Applications: High-performance interior latex.
 - 2. Exterior Applications: Exterior latex.
 - 3. Match gloss level to adjacent finishes when applicable. Flat gloss level for all other applications, unless otherwise indicated.

2.2. CONCRETE MATERIALS

- A. Concrete: Use the following unless otherwise indicated:
 - 1. Equipment Housekeeping Pads: Light-weight aggregate with 3000 psi, 28-day minimum compressive strength.
 - 2. Miscellaneous Uses: Medium-weight aggregate with 4000 psi, 28-day minimum compressive strength.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Welded Wire Steel Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3. GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
- B. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4. PATCHING MATERIALS

- A. General: Comply with requirements specified in other Sections.

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- 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.

2.5. ESCUTCHEONS AND FLOOR PLATES

- A. Escutcheons:
 - 1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 - 2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
 - 3. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- B. Floor Plates:
 - 1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 - 2. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.6. ACCESS DOORS AND FRAMES, WALLS AND CEILINGS

- A. Flush Access Doors with Concealed Flanges: Sheet steel door and frame, minimum 16-gauge, with face of door flush with frame, concealed flange and hinge, and key-operated lock and latch bolt.
 - 1. Finish: Factory-painted flat white for white ceiling and wall surfaces. Factory-primed for field painted surfaces.
 - 2. Coordinate frame styles with ceiling and wall types.
 - 3. Fire and Smoke-Rated Access Doors and Frames: Access doors located within fire and smoke-rated walls and ceilings shall be self-closing, listed and labelled by a qualified testing agency and comply with NFPA 80. Ratings shall meet or exceed the rating of the adjacent construction.

PART 3 - EXECUTION

3.1. DOCUMENTATION OF PROJECT CONDITIONS

- A. Project Conditions: Document in digital-format photos and video the existing project conditions and continue to document the conditions as the project progresses. Owner claims of contractor damage will be judged by the documented conditions.

3.2. OPERATION AND MAINTENANCE MANUALS

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- A. The contractors shall deliver one complete set of bookmarked manuals in electronic PDF format of all operation and maintenance manuals to the Owner through the Designer, two (2) weeks before the pre-final inspection is held. The manuals shall be bookmarked to a minimum of one level – ie: each major piece of equipment (chiller, boiler switchboard, water closet, water heater, etc.) or document category (warranties, parts list, contact information, etc.) The manuals shall be delivered by one of the following:
 - 1. USB Drive
 - 2. CD/DVD
 - 3. Downloadable file from FTP Site
- B. Manuals shall include the following (at a minimum):
 - 1. Index and page numbers
 - 2. Certificate of Owner Acceptance
 - 3. Summary sheet of warranties with dates noted and a copy of all warranties
 - 4. List of all subcontractors and suppliers with names, addresses, and phone numbers
 - 5. Special Inspection Reports
 - 6. Certified Test and Balance Report
 - 7. Complete start-up, operation, and shutdown procedures for each system including sequence of events, locations of switches, emergency procedures, and any other critical items.
 - 8. Lubrication schedules and types of lubricants
 - 9. Complete set of all submittal data and current shop drawings (including 3rd party generated shop drawings) and equipment description showing all capacities and other operation conditions.
 - 10. Equipment summary showing all capacities and ratings (HP, Tons, kW, filter size, etc.).

3.3. OPERATION OF HVAC SYSTEMS DURING CONSTRUCTION

- A. The Prime Contractor shall provide temporary heating, ventilation and air-conditioning as needed for the construction process. Use of the permanent HVAC is prohibited.
- B. Permanent HVAC systems and components may only be operated for verification, testing, adjusting and balancing.
- C. Owner/Engineer shall approve project conditions prior to system start-ups. Request start-up inspection minimum of 2 weeks prior to proposed start. Proposed start shall be coordinated with Owner's/Engineer's schedule.
- D. Air System Temporary Operation: Systems shall only be operated when the building is completely enclosed, is clean and there are no dust or fume creating activities being performed.

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1. Filtration: Prior to starting air systems, verify clean filters are installed in all air system equipment and clean temporary filter media is installed on all air intakes. Replace temporary filters on a regular basis. Provide minimum MERV-8 temporary filter media and comply with Section 234100. Replace all filters with new prior to Owner acceptance.
2. Air System Equipment Cleaning: Clean inside of air system equipment and install filters.
3. Air Handling Unit Control: The goal of construction conditioning is to remove excessive humidity to allow the installation of finishes. It is not to meet building design temperature.
 - a. Air handlers should be started initially at 100-percent outside air. Outside air intakes shall have a double layer of blue roll filter media, either at the outside air intake louvers or directly inside the unit prior to prefilters. If outside air intakes are going to be exposed to dust and dirt from site construction, consideration should be made to temporarily relocate intake by ducting to an elevation where the intake is protected from dirt and dust. Roll filter media should be periodically monitored for build-up and replaced as necessary. Do not operate unit while changing filters.
 - b. If systems do not have 100-percent outside air capability and return duct must be utilized, all return openings must be filtered to prevent contaminating the duct system and equipment.
 - c. When using return air, do not close outside air damper completely. Balance outside air flow to 10 to 20-percent of total flow to maintain positive pressure in the building.
- E. Hydronic System Temporary Operation: Systems shall only be operated when the spaces where pumps, motors and variable speed drives are located are clean and there are no dust or fume creating activities being performed.
 1. Cleaning: Prior to starting hydronic systems, verify motor housings are clean by using compressed air to blow out any dust and debris. Clean them on a regular basis during system operation.
- F. Owner/Engineer must approve operation of the permanent HVAC systems for use at Owner Acceptance.

3.4. WELDING AND BRAZING

- A. Medium and High Pressure Piping (Above 15 psig):
 1. Fabrication:
 - a. Medium and high pressure steam and heating water piping systems shall be fabricated, assembled and welded in accordance with ASME B31.1, and Power Piping Codes PFI ES 1, PFI ES 3, PFI ES 7, PFI ES 21, PFI ES 31, PFI ES 35, and PFI TB1 of the Piping Fabrication Institute's companion code requirements.
 - b. Other high pressure piping systems shall be fabricated, assembled and welded/brazed/ soldered in accordance with ASME B31.3, and Power Piping Codes PFI ES 1, PFI ES 3, PFI ES 7, PFI ES 21, PFI ES 31, PFI ES 35, and PFI TB1 of the Piping Fabrication Institute's companion code requirements.

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- c. Refrigeration piping systems shall be fabricated, assembled and welded/brazed in accordance with the ASME B31.5.
 - 2. Non-Destructive Inspection and Testing: All pipe welds shall be tested by a qualified, Engineer approved, testing agency at the expense of the contractor.
- B. Low Pressure Piping (15 psig and lower):
 - 1. Fabrication:
 - a. Copper make-up water and drainage piping systems shall be fabricated, assembled and soldered in accordance with ASTM B828.
 - b. Other low pressure piping systems shall be fabricated, assembled and welded/brazed in accordance with the ASME B31.9.
 - 2. Non-Destructive Inspection and Testing: Engineer shall visually inspect pipe welds. Based on visual inspections, upon order of the Engineer, non-destructive testing of selected pipe welds shall be performed by a qualified testing agency, at the expense of the Owner, using one of the following methods selected by the Engineer. The welds inspected shall be selected randomly, but the selection shall include an examination of welds made by each welding operator or welder.
- C. Testing Methods:
 - 1. Radiographic testing in accordance with ASTM E 94:
 - a. Make identification of defects by comparing radiographs to reference radiographs in ASTM E 390.
 - b. Film shall positively and properly identify as to member being inspected, location of weld, and location of film on weld.
 - c. Stamp identification on steel so film may be easily identified and matched to identification mark.
 - 2. Ultrasonic testing in accordance with ASTM E 164:
 - a. Size of defects will be determined by relating amplitude of oscilloscope traces to hole in ASTM reference weldment.
 - b. Diameter of reference holes shall be 3/32-inch.
 - c. Weld defects which are cause for rejection include cracks, lack of fusion, incomplete penetration, porosity, or slag inclusions which produce reflections equal to or greater than 80 percent of reference hole reflection and have linear dimensions as indicated by transducer movement exceeding 1/4-inch for material thickness up to and including 3/4-inch.
- D. Correction of Defective Welds: If random testing reveals that any welds fail to meet minimum quality requirements, an additional 10 percent of the welds in that same group shall be inspected at the Contractor's expense. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds shall be rejected. At the Contractor's

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option, the rejected welds shall be removed and the joints re-welded or the rejected welds shall be 100 percent tested as hereinbefore specified and all defective weld areas removed and re-welded.

1. If the initial testing reveals any deficient welds, then all initial and follow-up testing and all work required to replace the deficient welds shall be at the Contractor's expense.
2. If the initial testing does not reveal any deficiencies, then the initial testing shall be at the Owner's expense.

3.5. PAINTING

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and re-prime substrate with compatible primers as required to produce paint systems indicated.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. Painting of Division 23 Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 1. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 2. Duct, equipment, and pipe insulation having cotton, canvas or metal insulation covering or other paintable jacket material as required by Section 230553 and elsewhere as indicated.
 3. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
- E. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Engineer, and leave in an undamaged condition.
- F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6. CONCRETE

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301.
- B. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- C. Comply with ACI 301 for measuring, batching, mixing, transporting, and placing concrete.

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- D. Equipment Concrete Bases: Housekeeping pads shall match the indicated dimensions but not be less than required to extend 4-inches beyond the equipment footprint in each direction and have chamfered edges.
 - 1. Concrete Base Depths:
 - a. Air Handling Units: Minimum 6-inches thick, unless otherwise indicated.
 - b. HVAC Equipment: Minimum 4-inches thick, unless otherwise indicated.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.7. GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.8. WALL, FLOOR AND ROOF OPENINGS

- A. Exterior and interior wall, floor and roof openings made for duct, piping and conduit penetrations shall maintain the building's structural integrity. Install penetration sleeves, framing and lintels in accordance with the structural engineer.

3.9. ACCESS DOOR INSTALLATION

- A. Coordinate the need and exact location of each access door with Architect/Engineer prior to installation.

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- B. Center wall and ceiling access doors on duct access doors, valve centers, junction boxes, etc. to provide the best access to inspect, operate, and maintain the associated mechanical and electrical devices.
- C. Install wall and ceiling access doors level and square to building surfaces. Comply with manufacturer's written instructions.
- D. Install access doors such that their door swings are not blocked from opening fully and they open in the direction that provides the best access for the user.
- E. Adjust doors and hardware for proper installation.
- F. Touch-up door finishes with factory-provided paint as needed prior to completion.
- G. Verify fire and smoke-rated door labels have not been painted over in the field.
- H. Label wall and ceiling access doors with clear plastic ceiling tags in compliance with Section 23 05 53.

3.10. PIPING SYSTEM INSTALLATION GENERAL REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Refer to Section 230517 for more information about sleeves and sleeve seals.

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- M. Verify final equipment locations for roughing-in.
- N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- O. Piping Connections: Make piping connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping 2-inches NPS and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping 2-1/2 inches NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.11. ESCUTCHEONS AND FLOOR PLATES INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with inside diameter to closely fit around pipe, tube, and insulation of piping and with outside diameter that completely covers opening.
 - 1. New Piping: Install one-piece cast-brass type for new piping installations. Install deep-pattern type where piping sleeve protrudes from the floor or wall.
 - 2. Existing Piping: Install split-casting brass type for existing piping installations.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter to closely fit around pipe, tube, and insulation of piping and with outside diameter that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.
- E. Replace broken and damaged escutcheons and floor plates using new materials.

3.12. EQUIPMENT INSTALLATION GENERAL REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.13. MECHANICAL SYSTEM MOCK-UPS

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- A. General Requirements: Mechanical system mock-ups are intended to be initial installations of assemblies which serve as an approved example to be repeated several times throughout project installation. They are intended to coordinate the arrangement of associated components, connections by other trades and spatial requirements. Required mock-ups shall be installed, reviewed, modified and approved before the represented equipment is installed throughout the project. Mechanical system mock-ups are in addition to multi-trade mock-ups required in Division 1.
1. Mock-Up Pre-Installation Meetings: Prior to the mock-up installation, schedule Mock-Up Pre-Installation Meeting(s) in coordination with the monthly Owner Construction Coordination Meeting. Review the proposed mock-up location, requirements and schedule.
 2. Mock-Up Locations: Mock-up locations shall be determined in advance with the Engineer. They may be installed in a representative permanent location or in a temporary location if the permanent location is not ready.
 3. Mock-Up Installation: Mechanical system mock-ups shall include all components and connections including those of other trades. Temporary means may be used to represent general construction constraints such as ceilings and work by other trades.
 4. Mock-Up Review and Approval: Upon completion of the mock-up, the installation shall be reviewed with the Owner, Architect and Engineer to verify it meets the intent of the construction documents and is coordinated with other trades. Engineer approval does not constitute acceptance of work not conforming to the construction documents. The Contractor shall notify the Engineer of any differences between the mock-up and the construction document requirements. The Contractor should ask questions and / or make recommendations about the installations, so expectations are clear before it is repeated throughout the project.
 5. Documentation: Document all Engineer approved changes in the Record Drawings.
- B. Mock-Up Descriptions: Provide one mock-up of each unique situation for the following equipment:
1. Fan-Powered Terminal Units: Install one typical fan-powered terminal unit including inlet and outlet duct, heating coil piping and control valve assembly, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical elevations, maintenance access and clearances, and duct and wall/ceiling access doors.
 2. Single-Duct Terminal Units: Install one typical single-duct terminal unit including inlet and outlet duct, heating coil piping and control valve assembly, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical elevations, maintenance access and clearances, and duct and wall/ceiling access doors.
 3. Vertical Fan Coil Units: Install one typical vertical fan coil unit including ductwork (if applicable), heating and cooling coil piping and control valve assemblies, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical maintenance access and clearances.

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4. Horizontal Fan Coil Units: Install one typical horizontal fan coil unit including ductwork (if applicable), heating and cooling coil piping and control valve assemblies, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical elevations, maintenance access and clearances, and duct and wall/ceiling access doors.
5. Vertical Water-Source Heat Pump Units: Install one typical vertical water-source heat pump unit including ductwork (if applicable), condenser water piping and control valve assemblies, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical maintenance access and clearances.
6. Horizontal Water-Source Heat Pump Units: Install one typical horizontal water-source heat pump unit including ductwork (if applicable), condenser water piping and control valve assemblies, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical elevations, maintenance access and clearances, and duct and wall/ceiling access doors.
7. Rooftop Units: Install one typical packaged rooftop unit including roof curb / rails, ductwork connections, piping assemblies, controller, control conduit and wiring, disconnect switch, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical maintenance access and clearances.
8. Resident Room: In one typical resident room install HVAC equipment, duct and piping systems including all duct within suite and portions of adjacent duct mains, piping, power and control conduit and wiring, disconnect switches, power conduit and wiring, and wall, duct and pipe-mounted sensors. Installation should represent typical elevations, maintenance access and clearances, and duct and wall/ceiling access doors.

3.14. ADDITIONAL CONSTRUCTION PROCEDURES

- A. General Requirements: In addition to the requirements of Division 1 and individual Division 23 sections, the Contractor shall comply with the following requirements during project construction:
 1. Bidding: Review the requirements in the entire set of bid documents. Review the Project Documents paragraphs in Part 1 of this section. Submit clarification questions in compliance with Division 1 and Division 23.
 2. Submittals: Submit delegated design, qualification, product, construction and close-out submittals required in each Division 23 section. Utilize the Submittal List in Section 230110 to verify each submittal has been submitted and reviewed prior to the installation of related equipment and materials.
 3. Reference Documents: Maintain a hard copy set of Division 23 bid documents and submittals for reference in the on-site project office. Mark documents to record installed conditions and tested duct and piping.
 - a. Duct and Pipe Pressure and Leakage Testing: Upon successful completion of testing each section of duct and pipe, number, highlight, date and initial the tested sections. The section numbers shall match in the testing report. Each tested section shall be

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initialed by an appropriate representative from the Contractor and Owner / Commissioning Agent or Engineer.

- b. Life-Safety Dampers: Successfully tested life-safety dampers shall be highlighted and initialed by an appropriate representative from the Contractor and Owner / Commissioning Agent or Engineer.
- 4. Stored Material Verification: In coordination with each monthly Owner Construction Coordination Meeting, provide a copy of the month's proposed Payment Application and access to all equipment or material stored in an off-site insured and bonded warehouse for verification meeting the requirements of Division 1. Payment Applications with unverified off-site stored equipment and materials will not be approved.
- 5. Pre-Installation and Testing Meetings: Schedule Pre-Installation Meetings required in Division 23 sections with the Owner / Commissioning Agent and Engineer.
- 6. Equipment Start-Up: Schedule major equipment start-up procedures with the Owner / Commissioning Agent and Engineer.

END OF SECTION

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SECTION 23 02 00 – HVAC SYSTEMS OWNER TRAINING

PART 1 - GENERAL

1.1. SUMMARY

- A. This section includes general requirements for the owner's demonstration and training of Division 23 systems and equipment.

1.2. SUBMITTALS

- A. Construction Submittals:
 - 1. Instruction Program: Submit outline of instructional program for demonstration and training including proposed dates, times, lengths of instruction times, instructor's name and instructor's qualifications.
- B. Close-Out Submittals:
 - 1. Training Attendance List.
 - 2. Demonstration and Training Videos: Submit two copies within 14 days of the end of training program.

1.3. QUALITY INSURANCE

- 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 experienced in operation and maintenance procedures and training.
- C. Pre-Instruction Conference: Conduct conference at the project site. Review methods and procedures related to demonstration and training.
- D. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1. INSTRUCTION PROGRAM

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- 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. HVAC Control Systems
 - 2. Motor Starters and Disconnect Switches
 - 3. Variable Speed Drives
 - 4. Fans, Supply, Return, Relief and Exhaust
- 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 system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
 - 2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
 - 3. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
 - 4. Operations: Include startup, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
 - 5. Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
 - 6. Troubleshooting: Include diagnostic instructions and test and inspection procedures.
 - 7. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
 - 8. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

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- 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.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least 30 days' advance notice.
- D. Instruction Duration: Instructional time shall be no less than one (1) 8-hour days with an hour break for lunch, 8:00 am – 5:00 pm.
- E. Document training attendance for each session.

END OF SECTION

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SECTION 23 05 00 – HVAC FIRESTOPPING

PART 1 - GENERAL

1.1. SUMMARY

- A. This section includes firestopping requirements and information for Division 23 and 25 work.

1.2. DEFINITIONS

- A. Firestopping: The use of a material or combination of materials in a fire and/or smoke-rated structure (wall or floor) where it has been breached, so as to restore the integrity of the fire and/or smoke rating on that wall or floor.
- B. System: The use of a specific firestop material or combination of materials in conjunction with a specific wall or floor construction type and a specific penetrant(s).
- C. Barrier: Any bearing or non-bearing wall or floor that has an hourly fire and smoke rating.
- D. Through-Penetration: Any penetration of a fire-rated wall or floor that completely breaches the barrier.
- E. Membrane-Penetration: Any penetration in a fire and/or smoke-rated wall or floor/roof-ceiling assembly that breaches only one side of the barrier.
- F. Approved Testing Agencies: Not limited to: Underwriters Laboratory (UL), Factory Mutual (FM), and Intertek Group (IG).

1.3. PERFORMANCE REQUIREMENTS

- A. Penetrations: Provide through-penetration and membrane-penetration firestop systems that are produced and installed to resist the spread of fire, passage of smoke and other hot gases according to requirements indicated, to restore the original fire and smoke resistance rating of assembly penetrated.
- B. Provide and install complete penetration firestopping systems that have been tested and approved by nationally accepted testing agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
 - 1. F-Rated Systems: Provide firestop systems with F-ratings indicated and as required by the Building Code.
 - 2. T-Rated Systems: Provide firestop systems with T-ratings and F-ratings indicated and as required by the Building Code.
 - 3. L- Rated Systems: Provide firestop systems with L- ratings less than 5cfm/sf.
 - 4. W-Rated systems: Provide firestop systems that are resistant to water. For piping penetrations, provide moisture-resistant through-penetration firestop systems.

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- C. For penetrations involving non-metallic, CPVC, PVC, or plastic piping, tubing or conduit, provide firestop systems that are chemically compatible in accordance with Manufacturer requirements.
- D. For penetrations involving insulated piping, provide firestop systems not requiring removal of insulation.
- E. For penetrations involving fire or fire/smoke dampers, only firestop products approved by the damper manufacturer shall be installed in accordance with the damper installation instructions.
- F. Firestopping products shall have flame spread ratings less than 25 and smoke-developed ratings less than 450, as determined per ASTM E 84, except firestop products installed in plenum spaces shall have a smoke developed rating less than 50.
- G. Engineering Judgment (EJ): Where there is no specific third party tested and classified firestop system available for an installed condition, the Contractor shall obtain from the firestopping material manufacturer an Engineering Judgment (EJ) to be submitted to the Authority Having Jurisdiction (AHJ) and Engineer for approval. The EJ shall follow International Firestop Council (IFC) guidelines.

1.4. SUBMITTALS

- A. Product Submittals:
 - 1. Product Data: For each type of firestopping product selected. Manufacturers certification must verify that firestopping materials are free of asbestos, lead and contain volatile organic compounds (VOCs) within limits of the local jurisdiction. Include the following information:
 - a. Design Listings: Submit system design listings, including illustrations, from a qualified testing and inspecting agency that is applicable to each firestop configuration.
 - b. Installation Instructions: Submit the manufacturer's installation instruction for each firestop assembly.
 - c. Engineering Judgements: Where there is no specific third party tested and classified firestop system available for a particular configuration, the Contractor shall obtain from the firestopping material manufacturer an Engineering Judgment (EJ) for submittal.
 - d. Firestop Schedule: Submit schedule itemizing the following:
 - 1) Manufacturer's product reference numbers and/or drawing numbers.
 - 2) Listing agency's design number.
 - 3) Penetrating Item Description/Limits: Material, size, insulated or uninsulated, and combustibility.
 - 4) Maximum allowable annular space or maximum size opening.
 - 5) Construction type.

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6) F rating and, if applicable, T, L, and W ratings.

1.5. QUALITY ASSURANCE

- A. Provide firestopping system design listings from FM Global's "Building Materials Approval Guide", Intertek's "Directory of Listed Building Products", or UL's "Fire Resistance Directory" in accordance with the appropriate ASTM Standard(s).
- B. Single Source Limitations: Obtain firestop systems for all conditions from a single manufacturer.
 - 1. Materials from different firestop manufacturers shall not be installed in the same firestop system or opening.
- C. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.
- D. Firestopping sealants must be flexible, allowing for normal movement.
- E. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces such that a void is created.
- F. Firestopping materials shall be moisture resistant and may not dissolve in water after curing.
- G. Materials used shall be in accordance with the manufacturer's written installation instructions.
- H. All firestop materials shall be installed prior to expiration date. Store and handle materials per manufacturer's instructions to prevent deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.6. COORDINATION

- A. Coordinate areas prior to firestopping installation with the Owner, Construction Manager and/or all other Contractors.
- B. Coordinate construction of openings and penetrating items to ensure that firestopping assemblies are installed according to specified requirements. Opening shall not exceed maximum restrictions allowable for annular spacing per listing or acceptable Engineering Judgments.
- C. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- D. Do not conceal firestopping installations until the Owner's inspection agency or Authorities Having Jurisdiction have examined each installation.
- E. Schedule firestopping after installation of penetrants and joints but prior to concealing or obstructing access to areas requiring firestopping.

PART 2 - PRODUCTS

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2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Emerson / Nelson Firestop Products
 - 2. Hilti
 - 3. 3M, Fire Protection Products Division
 - 4. Tremco

2.2. FIRESTOPPING

- A. Firestopping products specified in system design listings by approved testing agencies may be used providing they conform to the construction type, penetrant type, annular space requirements and fire rating involved in each separate assembly.
- B. Accessories: Provide components for each firestop system that is needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by the firestopping manufacturer and by the approved testing agencies for the firestop systems indicated. Accessories include, but are not limited to the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag wool fiber insulation.
 - b. Foams or sealants used to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Polyethylene/polyurethane backer rod.
 - e. Rigid polystyrene board.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Steel sleeves
- C. All firestopping products and systems shall be designed and installed so that the basic sealing system will allow the full restoration of the thermal and fire resistance properties of the barrier being penetrated with minimal repair if penetrants are subsequently removed.
- D. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of zero (0) as determined by ASTM G21.

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

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- A. Provide firestop systems consisting of a material, or combination of materials installed to retain the integrity of fire resistance rated construction by maintaining an effective barrier against the spread of flame, smoke and/or hot gases through penetrations, fire resistive joints, and perimeter openings in accordance with the requirements of the Building Code for this project.
- B. Firestop systems shall be used in locations including, but not limited to, the following:
 - 1. Penetrations through fire resistance rated floor and roof assemblies including both empty openings and openings containing penetrants.
 - 2. Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants.
 - 3. Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.

3.2. EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that all pipes, conduits, cables, and/or other items which penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.3. PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing firestop systems to comply with written recommendations of firestopping manufacturer and the following requirements:
- B. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of firestop systems.
- C. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestop systems. Remove loose particles remaining from cleaning operation.
- D. For those products requiring mixing before application, comply with firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

3.4. INSTALLATION

- A. General: Install firestop systems to comply with firestopping manufacturer's written installation instructions and published drawings for products and applications indicated.

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- B. Apply firestopping in accordance with approved testing agencies listed system designs or manufacturer's EJ per the manufacturer's installation instructions.
- C. Verify that environmental conditions are safe and suitable for installation of firestop products. Application areas shall be protected from weather, dry and within recommended temperature and humidity ranges of materials being installed.
- D. Install forming/damming/backing materials and other accessories required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire resistance ratings required.
- E. Install metal framing, mechanical attachments, safing materials and firestop materials as applicable within the system design.
- F. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids, joints and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they fully contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
 - 4. Tool non-sag firestop materials after their application and prior to the time skinning begins. Use tooling agents approved by the firestopping manufacturer.
- G. On vertical pipe penetrations, lift riser clamps to permit the installation of firestopping around the entire pipe penetration. For penetrations involving fire or fire/smoke dampers, only firestop products approved by the damper manufacturer shall be installed in accordance with the damper installation instructions.
- H. Label penetration ratings and UL detail numbers on wall surfaces directly adjacent to the penetrations. This information shall be readily visible in non-occupied spaces, within chases and above ceilings.
 - 1. Comply with Section 230553 for identification and labeling requirements.

3.5. FIELD QUALITY CONTROL

- A. Inspecting Agency: Authorities Having Jurisdiction, the Owner, or Owner's Representative shall be allowed to perform random destructive testing during inspection of firestop systems to verify compliance per listings or manufacturer's installation instructions. All areas of work must be accessible until inspection by the applicable Authorities Having Jurisdiction and inspection agencies. The contractor shall be responsible to repair all tested assemblies with no cost to the owner.
 - 1. Refer to Division 1 and Section 230100 regarding Special Inspections requirements.
- B. Proceed with enclosing firestop systems with other construction only after inspections are complete.

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- C. Where deficiencies are found as determined by the Engineer, remove and replace firestop systems so they comply with requirements.

3.6. CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings, as work progresses by methods and with cleaning materials that are approved in writing by firestopping manufacturer(s) and that do not damage materials in which openings occur. Leave finished work in neat, clean condition with no evidence of spillovers or damage to adjacent surfaces.
- B. Provide final protection and maintain conditions during and after installation that ensure firestop systems are without damage or deterioration at time of Owner Acceptance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestop systems immediately and install new materials to produce firestop systems complying with specified requirements.

END OF SECTION

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SECTION 23 05 11 – HVAC ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1. SUMMARY

- A. This section includes electrical equipment, materials and work that are the responsibility of Division 23.

1.2. SUBMITTALS

A. Product Submittals:

- 1. Product Data: For each type of device, include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- 2. Electrical Connections: Submitted equipment nameplates shall be coordinated with the indicated design electrical characteristics. If the submitted equipment requires changes to the electrical connection(s) (including conduit, wire, circuit breaker, fuse, starter, and disconnect sizes, connection locations, etc.) comply with the requirements of Section 230100. Any changes required to accommodate the equipment shall be responsibility of the contractor.
 - a. Proposed changes to the design shall be submitted to the Engineer for review and approval.
 - b. Accepted changes shall be noted by the contractor on the as-built documentation.

B. Close-Out Submittals:

- 1. Operation and Maintenance Data: For disconnects, motor starters and combination motor starters and disconnects, to include in emergency, operation and maintenance manuals.

1.3. QUALITY ASSURANCE

- A. Source Limitations: Obtain motor starters, disconnect switches and combination motor starters and disconnect switches of a single type through one source from a single manufacturer.
 - 1. Exceptions: Disconnect switches that are factory-mounted to HVAC equipment may be provided by the equipment manufacturer.
- B. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

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1. Where requirements of Division 23, Division 26 or NFPA 70 conflict, conform to the strictest requirements.
- C. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- D. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.4. 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: One set for each fused device.

PART 2 - PRODUCTS

2.1. EQUIPMENT ENCLOSURES

- A. Provide NEMA-rated equipment enclosures for all disconnect switches, motor starters, control panels, variable speed controllers and other similar electrical equipment. When not otherwise indicated, provide enclosures based on the environments of the installations.
 1. Inside, Clean Spaces without Water Piping: NEMA 1.
 2. Inside, Utility Spaces and Spaces with Water Piping: NEMA 12.
 3. Outside, Normal Ambient Conditions: NEMA 3R.
 4. Inside or Outside, Water Features and Equipment (Pools, Fountains, Aquariums, etc.) Spaces: NEMA 4X
 5. Inside or Outside, Manholes, Tunnels and Sumps: NEMA 6
 6. Inside or Outside, NEC Hazard Class 1 Locations: NEMA 8
 7. Inside or Outside, NEC Hazard Class 2 Locations: NEMA 9

2.2. DISCONNECT SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Eaton
 2. ABB/General Electric
 3. Schneider Electric/Square D

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- B. Fusible Disconnect Switches: Single-throw, heavy-duty, service-rated fusible switch, rated for 200 to 600Vac and labeled and listed UL 98 and NEMA KS 1, Type HD with silver-tungsten type fuse clips and equipment ground and neutral kit. When a neutral is not necessary, bond the neutral bus to the enclosure for use as grounding bus. Internal current-carrying components shall be solid copper. Provide auxiliary contacts when needed for control system interface.
- C. Non-Fusible Disconnect Switches: Single-throw, heavy-duty, service-rated switch, rated for 200 to 600Vac and labeled and listed UL 98 and NEMA KS 1, Type HD with equipment ground and neutral kit. When a neutral is not necessary, bond the neutral bus to the enclosure for use as grounding bus. Internal current-carrying components shall be solid copper. Provide auxiliary contacts when needed for control system interface.
- D. Provide switch accessories required to meet the system requirements indicated.

2.3. MOTOR STARTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Eaton
 - 2. ABB/General Electric
 - 3. Schneider Electric/Square D
- B. Description: Full-voltage, electrically-held, non-reversing, magnetic motor controllers with 24Vac control circuit, hand-off-auto (HOA) switch, push-to-start switch, manual reset switch, auxiliary control and monitoring contacts and accessories required to meet the system requirements indicated. Cover door shall have red and green pilot lights. The green light shall illuminate when “on”, and red shall illuminated when “off”.

2.4. COMBINATION MOTOR STARTERS AND DISCONNECT SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Eaton
 - 2. ABB/General Electric
 - 3. Schneider Electric/Square D
- B. Description: Combination magnetic motor starter and circuit breaker disconnecting means with auxiliary contacts.
 - 1. Disconnecting Means: Thermal magnetic type molded-case circuit breaker (MCCB) with adjustable instantaneous-trip for each pole, auxiliary control and monitoring contacts and test trip button.
 - 2. Motor Starter: Full-voltage, electrically-held, non-reversing, magnetic motor controllers with 24Vac control circuit, hand-off-auto (HOA) switch, push-to-start switch, manual reset switch, auxiliary control and monitoring contacts and accessories required to meet the system requirements indicated. Cover door shall have red and green pilot lights. The green light shall illuminated when “on”, and red shall illuminated when “off”.

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2.5. MANUAL MOTOR SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Eaton
 - 2. ABB/General Electric
 - 3. Schneider Electric/Square D
- B. Description: Manual motor starter and disconnect switch with thermal overload protection for fractional horsepower motors. Toggle switch shall provide manual “on/off” control of one or two-pole single-phase motors rated up to 1 horsepower. The enclosure shall have green pilot light. The green light shall illuminate when “on”. The switch shall have a hand guard to prevent accidental operation and provisions for a padlock in the “off” position. The switch shall be rated for single or two-speed applications as indicated. The enclosure shall be for flush wall-mounting where possible and surface wall-mounting where not.

2.6. FUSES

- A. Description: Non-renewable cartridge fuses of the type and size required by NFPA 70 and Division 26.

2.7. SHORT-CIRCUIT CURRENT RATINGS

- A. Overcurrent protection devices shall be rated for the ampere interruption current rating indicated in the Division 26 documents. Where the rating is not indicated, provide devices rated for 65,000 AIC.

2.8. POWER AND CONTROL CABLING AND RACEWAY

- A. Low-Voltage (100 to 600 V) Power Feeders: Size conductors and raceway per NFPA 70 and Division 26 based on equipment nameplate requirements and manufacturer’s installation recommendations.
- B. Control-Voltage (Up to 24 V) Cabling: Provide control cabling for HVAC system per NFPA 70 and Division 26 based on the system manufacturer’s installation recommendations.
 - 1. Paired Cabling: No. 16 AWG Type CMP plenum-rated twisted pair.
 - 2. Class 1 and 2 Control Circuits: Stranded copper Type THHN-THWN.
 - 3. Class 3 Control Circuits: Stranded copper Type TW or TF.
- C. Power Conductors: Copper, solid for No. 10 AWG and smaller and stranded for No. 8 AWG and larger, with THHN-THWN insulation. Aluminum conductors will not be accepted.
- D. Grounding Conductors: Copper, solid for No. 8 AWG and smaller and stranded for No. 6 AWG and larger, with THHN-THWN insulation. Aluminum conductors will not be accepted.
- E. Conduit:

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1. EMT (electrical metallic tubing): Indoor, above-grade applications not subject to damage.
2. RGS (rigid galvanized steel): Indoor, above-grade applications subject to damage and outdoor, above-grade applications.
3. RNC (rigid non-metallic conduit), Type Schedule 40 PVC: Indoor and outdoor, below-grade applications.
4. FMC (flexible metallic conduit): Indoor, above-ceiling applications.
5. LFMC (liquid-tight flexible metal conduit): Outdoor, above-grade applications.

PART 3 - EXECUTION

3.1. INSTALLATION

- A. Disconnect Switches: Provide disconnect switches for all HVAC equipment. Disconnect switches shall be sized to comply with NFPA 70. Single fan, blower and pump motors shall be based on nameplate horsepower. All other applications shall be based on nameplate total kW rating. Disconnects shall be provided with dual-element fuses sized based on equipment nameplate rating.
1. Service Disconnect Switches: Where the disconnecting means is not within the line-of-sight, as defined by NFPA 70 and the authority having jurisdiction (AHJ), an additional service disconnect shall be located adjacent to the equipment it feeds.

DISCONNECT SWITCH SIZES for MOTORS						
AMPERAGE RATING	MAX HP at VOLTAGE/PHASE					
	115V/1ph	200V/1ph	230V/1ph	200V/3ph	230V/3ph	460V/3ph
30A	1.5	3	3	5	7.5	15
60A	3	7.5	10	15	15	30
100A	-	-	-	25	25	60
200A	-	-	-	50	60	100
400A	-	-	-	100	125	250

DISCONNECT SWITCH SIZES for EQUIPMENT							
AMPERAGE RATING	MAX KW at VOLTAGE/PHASE						
	120V/1ph	208V/1ph	240V/1ph	277V/1ph	208V/3ph	240V/3ph	480V/3ph
30A	2.8	5.0	5.8	6.6	8.6	10.0	19.9
60A	5.8	10.0	11.5	13.3	17.3	19.9	39.9
100A	9.6	16.6	19.2	22.2	28.8	33.2	66.4
200A	19.2	33.3	38.4	44.3	57.6	66.4	132.9
400A	38.4	66.6	76.8	88.6	115.1	132.9	265.7
600A	57.6	99.8	115.2	133.0	172.7	199.3	398.6

- B. Motor Starters: Provide all motor starters where required for HVAC equipment to operate as intended. Motor starters shall be sized to comply with NFPA 70 and NEMA rated for magnetic starters.

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NEMA STARTER SIZES					
NEMA SIZE	MAX HP at MOTOR VOLTAGE/PHASE				
	115V/1ph	230V/1ph	200V/3ph	230V/3ph	460V/3ph
00	0.33	1	1.5	1.5	2
0	1	2	3	3	5
1	2	3	7.5	7.5	10
2	-	7.5	10	15	25
3	-	-	25	30	50
4	-	-	40	50	100
5	-	-	75	100	200

- C. Combination Motor Starters and Disconnect Switches: Provide combination motor starters and disconnect switches that meet the requirements of the “Motor Starters” article above. Combination motor starters and disconnect switches shall be used unless otherwise noted or prohibited by NFPA 70.
- D. Manual Motor Switches: Provide manual motor switches for fractional horsepower fan, blower and pump motors that do not require automated start and stop functions.
- E. Furnish and install device fuses per equipment unit nameplate.
- F. Size and adjust circuit breaker disconnect switches per equipment unit nameplate.
- G. Electrical Connections: All electrical connections shall be made in accordance with equipment manufacturer’s recommendations and in accordance with NFPA 70. Install and ground equipment connections in accordance with the requirements of NFPA 70 and Division 26.
 - 1. Electrical Connections, Low Voltage (100 to 600 V): Division 23 contractor is responsible for power wiring and conduit from the equipment connections to the disconnecting means. Division 26 is responsible for the power circuit from the power source to the disconnecting means.
 - 2. Electrical Connections, Control Voltage (Up to 24 V): Division 23 contractor is responsible for all control voltage wiring and conduit for HVAC equipment and controls from the low voltage power source disconnecting means. Division 26 is responsible for the low voltage power circuit from the power source to the disconnecting means.
 - a. Low Voltage Disconnecting Means: Where dedicated low voltage circuits are indicated in Division 26 documents, the disconnecting means shall be defined as the disconnect switch or junction box provided. Where dedicated low voltage circuits are not explicitly indicated in Division 26 documents, the disconnecting means shall be defined as 20A/1P spare circuit breakers in panelboards.
- H. Wiring Pathway, Low and Control Voltage: All low and control voltage power and control wiring shall be installed in conduit unless otherwise noted.
 - 1. Surface-mounted raceway may only be used when indicated or Engineer approved prior to installation. In most cases, conduits shall be installed within walls, above ceilings and below floor slabs. Cut and repair substrates to install raceway.

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2. Control voltage cabling shall be plenum-rated and organized with J-hooks when control cabling is not required by the Engineer to be installed in conduit.
- I. Conduit:
 1. Flexible Connections: Provide flexible connections for all vibrating equipment including fans, pumps, compressors, etc. Flexible connections shall be no more than 24-inches long.
 2. Areas Subject to Damage: In areas where the conduit will be exposed and is subject to damage, such as mechanical equipment rooms, RGS conduit shall be installed to no less than 8-feet above finished floor and EMT may be used above 8-feet.
 - J. Grounding and Bonding: Ground and bond equipment and circuits in accordance with the requirements of NFPA 70 and Division 26.
 - K. Install duct-mounted smoke detectors, furnished and wired by Division 26. Provide duct access doors for proper maintenance and access.
 - L. Smoke-rated life-safety dampers shall be wired and controlled by Division 26.
 - M. Smoke control system devices shall be wired and controlled by Division 26.

3.2. FIELD QUALITY CONTROL

- A. Comply with NFPA 70E per OSHA 29CFR Part 1910.5, Appendix A.

3.3. DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain electrical devices.

END OF SECTION

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SECTION 23 05 13 – HVAC EQUIPMENT MOTORS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes general requirements for all HVAC motors

1.2. QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

PART 2 - PRODUCTS

2.1. GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.
- C. Motors for fans and pumps shall be selected for the maximum brake-horsepower listed in the equipment schedules and no more than 85% of the nominal rated horsepower excluding the service factor.

2.2. MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea-level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3. POLYPHASE MOTORS

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- A. Description: NEMA MG 1, Design B, medium induction motors.
 - 1. General Use:
 - a. Open drip-proof (ODP) motors.
 - b. Totally enclosed over air (TEOA).
 - c. Totally enclosed fan cooled (TEFC).
- B. Efficiency: All motors shall be Premium Efficiency conforming to the requirements of NEMA MG1 Part 31. Conform to 10 CFR Part 431 published by the US Department of Energy - Efficiency standard for integral horsepower motors.
 - 1. Minimum efficiency shall meet the requirements of the State Energy Conservation Code and ASHRAE 90.1.
- C. Service Factor: 1.15.
 - 1. Multispeed Motors: Variable torque.
 - 2. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 3. For motors with other than 2:1 speed ratio, separate winding for each speed.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Class B.
- G. Insulation: Class F.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4. POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

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2. Inverter-Duty Motors: Motors shall be “Inverter-Duty” rated according to NEMA MG 1 Part 31, “Requirements for Definite Purpose Inverter-Fed Polyphase Motors”, with minimum Class F temperature rise and Class H insulation. NEMA duty rating code on motor nameplate shall indicate “Inverter-Duty”. Other duty rating code markings such as “Inverter-Ready” are not acceptable.
 3. Shaft Grounding Rings (SGR): Motors shall have solid or split type shaft grounding rings designed to prevent bearing damage due to adjustable speed drive induced currents. SGR shaft diameter shall match the motor’s standard NEMA “u” dimension.
 4. Thermal Protection: Comply with NEMA MG 1 Part 12.56, “Thermal Protection of Medium Motors” requirements for thermally protected motors, including a manual-reset type thermal protection device.
 5. Under-Speed Operation: Motors shall be capable of continuous operation at minimum design operating speed indicated on the drawings. Where minimums are not indicated, motors shall be capable of continuous operation at the following minimum speeds.
 - a. Fans: 18 Hz (30-percent).
 - b. Pumps: 12 Hz (20-percent).
- C. Electronically-Communicated (EC) Motors
1. Electronically-communicated (EC) motors, also known as brushless DC electric (BLDC) motors, shall be NEMA MG 1, totally enclosed fan cooled (TEFC), inverter-use, motors with integrated microprocessor speed controller designed for variable speed and torque fan and pump applications.
 - a. Speed controller shall be programmed with safeties to avoid damaging conditions and unstable fan / pump operation. Firefighter’s safety override mode shall allow bypass of most speed controller safeties.
 - b. Speed controller shall comply with requirements of Section 230514.

2.5. SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

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- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 23 05 14 – VARIABLE SPEED CONTROLLERS

PART 1 - GENERAL

1.1. SUMMARY

- A. This section includes solid-state, pulse-width modulated, variable speed motor controllers for three-phase, squirrel-cage induction motors.

1.2. SUBMITTALS

- A. Delegated Design Submittals:
 - 1. Harmonic Distortion Analysis: Submit the harmonic distortion analysis, including all assumptions, calculations and results for review by the Engineer.
- B. Product Submittals:
 - 1. Product Data: For each type of variable speed controller, include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- C. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For variable speed controllers, all installed devices, and components to include in emergency, operation, and maintenance manuals.
 - a. Routine maintenance requirements for variable speed controllers and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.3. QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain variable speed controllers of a single type through one source from a single manufacturer.
 - 1. Exceptions: Variable speed controllers that are factory-mounted to HVAC equipment, such as chillers and cooling towers, and branded by the equipment manufacturer may be provided by the equipment manufacturer.

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- C. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- D. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- E. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for variable speed controllers minimum clearances between the controllers and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4. DELIVERY, STORAGE, AND HANDLING

- A. Deliver variable speed controllers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store variable speed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.5. PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: 32 to 105 deg F.
 - 2. Humidity: Less than 90 percent (non-condensing).
 - 3. Altitude: Not exceeding 3300 feet.
- B. NEMA-rated enclosures for the installed environment. Refer to Section 230511.

1.6. COORDINATION

- A. Coordinate layout and installation of variable speed 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.
- C. Coordinate features of variable speed controllers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each variable speed controller and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

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1.7. WARRANTY

- A. Special Warranty: Manufacturer's complete parts and labor warranty for 3-years from the date of Owner Acceptance.

1.8. EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: One set of three for each variable speed controller.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB.
 - 2. Danfoss.
 - 3. Yaskawa.

2.2. VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA 2, integrated-gate bipolar transistor (IGBT), pulse-width modulated (PWM), variable frequency controller listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency. Provide unit suitable for operation of premium efficiency motor as defined by NEMA MG 1.
 - 1. Provide 6-pulse drives.
- B. Design and Rating: Match load type such as fans, blowers and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 66 Hz, with torque constant as speed changes.
- D. Unit Operating Requirements:
 - 1. Input ac voltage tolerance of 208 V, plus or minus 5 percent; 380 to 500 V, plus or minus 10 percent; and 525 to 575 V, plus or minus 10 percent.
 - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.

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4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range with an electrical signal of 4 to 20 mA at 24V.
- F. Internal Adjustability Capabilities:
 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
 6. Self-Protection and Reliability Features:
 7. Input transient protection by means of surge suppressors.
 8. Under and over-voltage trips; inverter over-temperature, overload, and overcurrent trips.
 9. Motor Overload Relay: Adjustable and capable of NEMA 2, Class 20 performance.
 10. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 11. Instantaneous line-to-line and line-to-ground overcurrent trips.
 12. Loss-of-phase protection.
 13. Reverse-phase protection.
 14. Short-circuit protection.
 15. Motor over-temperature fault.
- G. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- I. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

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- J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- K. Input Line Conditioning: 5% Line Reactor.
- L. VFC Output Filtering: Load reactors (dV/dt filters) for distances greater than 50 feet between drive and load.
- M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (Vdc).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- P. Control Signal Interface:
 - 1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 - 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the building automation system (BAS) or other control systems:
 - a. 0 to 10-V dc.

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- b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
- 3. Output Signal Interface: Minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (VDC).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set-point frequency (Hz).
- 4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (over-temperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- Q. Communications: Provide an RS485 interface allowing variable frequency controller to be used with an external system within a multi-drop local area network (LAN) configuration. Interface shall allow all parameter settings of variable frequency controllers to be programmed via building automation system (BAS) control. Provide capability for variable frequency controllers to retain these settings within the nonvolatile memory.
 - 1. BAS Interface: Factory-installed hardware and software to enable the building automation system (BAS) to monitor, control and display unit status and alarms. BACnet communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.
- R. Integral Disconnecting Means: Door interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000A.
- S. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3. ENCLOSURES

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- A. Provide NEMA-rated enclosure appropriate for the installed environment. Refer to Section 230511 for more information.

2.4. ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays: Door mounted display shall include:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine areas, surfaces, and substrates to receive variable speed controllers for compliance with requirements, installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before variable speed controllers installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2. APPLICATIONS

- A. Select features of each variable speed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Select amperage rating of controllers to suit multiple motor applications.
- D. Variable speed drives shall be furnished for each motor. Do not operate more than one motor on a single variable speed drive unless otherwise noted.

3.3. INSTALLATION

- A. Anchor each variable speed controller assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.
- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.
- D. Seal interior electronics in plastic wrap to protect from dirt during installation. Remove plastic wrap when complete. Cover enclosure vents with MERV-5 filter media prior to using VFD's during construction. Keep VFD's clean. Vacuum dirt and metal shavings from inside and outside of VFD enclosure.

3.4. IDENTIFICATION

- A. Identify variable speed controllers, components, and control wiring according to Section 230553.

3.5. CONTROL WIRING INSTALLATION

- A. Install wiring between variable speed controllers and remote devices according to Division 26.
- 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 control 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

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- A. Conduit installation requirements are specified in Division 26. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26.

3.7. FIELD QUALITY CONTROL

- A. Factory-trained technician shall perform start-up.
 - 1. Technician shall utilize manufacturer's software with laptop to upload parameters in compliance with manufacturer's warranty.
 - 2. Start-ups shall be witnessed by the Owner and performed prior to TAB.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.8. 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 variable frequency controllers.

END OF SECTION

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SECTION 23 05 17 – SLEEVES AND SLEEVE SEALS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes sleeves, sleeve seals and associated materials.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.

PART 2 - PRODUCTS

2.1. SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: Minimum 20-gauge thickness; round tube closed with welded longitudinal joint.
- E. PVC pipe sleeves are not acceptable.

2.2. SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field-assembly for filling annular space between piping and sleeve. The sealing elements shall be interlocking links shaped to fit pipe surface. GPT Link-Seal or Engineer approved equal.
 - 1. Piping Systems, 180 deg F and below:
 - a. Sealing Elements: EPDM-rubber or NBR (nitrile butadiene rubber).
 - b. Pressure Plates: Reinforced Nylon Polymer.
 - c. Connecting Bolts and Nuts: Stainless steel or carbon steel with corrosion resistance coating.
 - d. Constant Temperature Rating: 200 deg F.

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2. Piping Systems, above 180 deg F:
 - a. Sealing Elements: Silicone.
 - b. Pressure Plates: Steel with corrosion resistance coating.
 - c. Connecting Bolts and Nuts: Stainless steel or carbon steel with corrosion resistance coating.
 - d. Constant Temperature Rating: 300 deg F.
- B. PVC sleeve seal systems are not acceptable.

2.3. GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1. SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 1. Insulated piping systems shall have insulation continue through penetrations without interruption. Insulation joints shall not occur within sleeves.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch minimum annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and masonry walls as new slabs and walls are constructed.
 1. Walls: Cut sleeves to length for mounting flush with both surfaces.
 2. Floors: Extend sleeves 1-inch above finished floor and seal penetrations watertight.
 3. Mechanical Equipment Room and Wet Area Floors: Extend sleeves 2-inches above finished floor and seal penetrations watertight.
 4. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.

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1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements of sealants.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping and associated U.L. detail.

3.2. SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior masonry walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3. SLEEVE AND SLEEVE-SEAL SYSTEM SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Cast-Iron Pipe Sleeves with Sleeve Seal Systems: Masonry walls above and below grade and concrete slabs on grade.
 - a. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 2. Galvanized Steel Pipe Sleeves: Interior fire-rated partitions; interior non-rated partitions; and concrete slabs above grade.
 3. Galvanized Steel Sheet Sleeves: Interior non-rated partitions.

END OF SECTION

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SECTION 23 05 19 – PIPING INSTRUMENTS AND GAGES

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes instruments and gages for HVAC systems.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. Product Certificates: For each type of instrument and gage from manufacturer.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For instruments and gages to include in operation and maintenance manuals.

1.3. QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

PART 2 - PRODUCTS

2.1. THERMOMETERS

- A. Standard: ASME B40.200.
- B. Light-Activated Thermometers: 6-inch metal or plastic case with adjustable angle; digital display with scale graduated in deg F and deg C; aluminum stem of length suitable for application for Thermowell installation; 1-1/4 inch connector with ASME B1.1 screw threads; and accuracy to plus or minus 1 deg C.
- C. Thermometer Scale Ranges for Piping Systems:

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1. Chilled Water: 0 to 100 deg F.
 2. Heating Water: 0 to 250 deg F.
- D. Thermometer stems shall be of length to match thermowell insertion length.

2.2. THERMOWELLS

- A. Standard: ASME B40.200.
- B. Thermowells: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
1. Material for Use with Copper Tubing: Copper-nickel (90-10) or copper-nickel (70-30).
 2. Material for Use with Steel Piping: Corrosion resistant steel.
 3. Type: Stepped shank unless straight or tapered shank is indicated.
 4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 6. Bore: Diameter required to match thermometer bulb or stem.
 7. Insertion Length: Length required to match thermometer bulb or stem.
 8. Lagging Extension: Include on thermowells for insulated piping and tubing.
 9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- C. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3. PRESSURE GAGES

- A. Standard: ASME B40.100.
- B. Dial-Type Pressure Gages: Oil-filled, cast aluminum case with 4-1/2 inch nominal diameter; non-reflective aluminum dial with permanently etched scale markings graduated in psi and kPa; bourbon tube pressure element assembly; brass pressure connection with NPS 1/4 or 1/2 inch ASME B1.20 pipe threads and bottom-outlet; mechanical movement with link pressure element and connection to pointer; glass window; stainless steel ring; dark colored metal pointer; and accuracy to plus or minus 1 percent of scale range.
- C. Scale Ranges for Piping Systems:
1. Chilled Water: 0 to 100 psi.
 2. Heating Water: 0 to 100 psi.

2.4. GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.

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- B. Siphons: Loop-shaped section of stainless pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5. TEST PLUGS

- A. Test Plug: Test-station fitting made for insertion into piping tee fitting; brass or stainless steel body including extended stem when used on insulated piping; core inserts and gasketed and threaded cap; ASME B1.20.1 pipe threads; chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber core inserts; rated for a minimum of 500 psig at 200 deg F.

2.6. TEST-PLUG KITS

- A. Furnish one test-plug kit containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall match diameter to fit test plugs and of length to project into piping.
- B. Low-Range Thermometer: Small, bimetallic insertion type with 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- C. High-Range Thermometer: Small, bimetallic insertion type with 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1. INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

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- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Install permanent indicators on walls or brackets in accessible and readable positions.
- O. Install connection fittings in accessible locations for attachment to portable indicators.
- P. Install thermometers in the inlet and outlet piping of each:
 - 1. Hydronic zone.
 - 2. Hydronic boiler.
 - 3. Chiller, chilled water and condenser water connection.
 - 4. Air-handling unit hydronic coil.
 - 5. Hydronic heat exchanger.
- Q. Install pressure gages in the inlet and outlet piping of each:
 - 1. Pressure-reducing valve.
 - 2. Chiller, chilled water and condenser water connection.
 - 3. Pump.
 - 4. Hydronic heat exchanger.
 - 5. Thermal storage tank.
 - 6. Air and/or dirt separators.
- R. Install temperature and pressure test ports at each terminal unit reheat coil.

3.2. ADJUSTING

- A. Adjust faces of instruments and gages to proper angle for best visibility.

END OF SECTION

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SECTION 23 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes pipe hangers and hanger shields, metal framing systems, fastener systems, pipe-stands and equipment supports.

1.2. PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment.

1.3. SUBMITTALS

- A. Qualification Submittals: Welding certificates.
- B. Product Submittals: For each type of product indicated.

1.4. QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1. METAL PIPE HANGERS AND SUPPORTS

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- A. Carbon-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components. Hangers shall be galvanized. Padded hangers shall be fiberglass pad or cushion to support bearing surface of piping. Hanger rods shall be continuously threaded with nuts and washers made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components. Padded hangers shall be fiberglass pad or cushion to support bearing surface of piping. Hanger rods shall be continuously threaded with nuts and washers made of stainless steel.
- C. Copper Pipe Hangers: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Hanger rods shall be continuously threaded with nuts and washers made of stainless steel.

2.2. TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3. METAL FRAMING SYSTEMS

- A. Description: Shop or field-fabricated pipe-support assembly for supporting multiple parallel pipes. Channels shall be continuous slotted steel with in-turned lips. Channel nuts shall be designed to fit into channel slot and when tightened to prevent slipping. Hanger rods shall be continuously threaded with nuts and washers made of carbon steel.

2.4. THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength. For cold piping systems, include vapor barrier.
- B. Insert and shield shall cover the entire pipe circumference for trapeze of clamped systems and cover the lower 180-degrees of pipe circumference for clevis or band hangers.
- C. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5. FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6. EQUIPMENT SUPPORTS

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- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7. MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1. HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 2 1/2-inches NPS and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping. Clamps may project through the insulation of hot piping systems. Use thermal hanger shield inserts with clamp sized to match outside diameter of insert for cold piping systems.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. Less than 4-inches NPS: 12-inches long and 0.060-inch thick.
 - b. 4 to 6-inches NPS: 18-inches long and 0.060-inch thick.
 - c. 8 to 14-inches NPS: 24-inches long and 0.075-inch thick.
 - d. 16 to 24-inches NPS: 24-inches long and 0.105-inch thick.
 - 5. Pipes 8-inches NPS and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2. EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3. METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

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1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4. ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1 1/2 inches.

3.5. PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6. HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.

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- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1)
 - 2. Split-Ring Hangers (MSS Type 69): Piping 2-inches NPS and smaller.
 - 3. Copper Pipe Hangers: For copper piping.
- K. Trapeze Pipe-Hangers: Trapeze hangers shall be welded carbon steel pre-formed structural members suspended by threaded rods. Comply with MSS SP-69. Each pipe shall be individually supported.
 - 1. Adjustable Pipe Saddles (MSS Type 38)
 - 2. Copper Pipe Saddles: For copper piping.
- L. Vertical-Piping Clamps:
 - 1. Riser Clamps (MSS Type 8)
- M. Building Attachments: Install MSS compliant devices for all building attachments. Install them per manufacturer's instructions.
- N. Saddles and Shields:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 4. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 - 5. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 - 6. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

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7. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types: horizontal (MSS Type 54), vertical (MSS Type 55) or trapeze (MSS Type 56).
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7. PIPE HANGER INSTALLATION

- A. Steel Piping: Install hangers for steel piping with the following minimum rod sizes and maximum spacing:
 1. 1 1/4-inch NPS and smaller: 3/8-inch diameter at 7-foot span.
 2. 1 1/2-inch NPS: 3/8-inch diameter at 9-foot span.
 3. 2-inch NPS: 3/8-inch diameter at 10-foot span.
 4. 2 1/2-inch NPS: 1/2-inch diameter at 10-foot span.
 5. 3-inch NPS: 1/2-inch diameter at 12-foot span.
 6. 4-inch NPS: 5/8-inch diameter at 12-foot span.
 7. 6-inch NPS: 3/4-inch diameter at 12-foot span.
 8. 8 to 12-inch NPS: 7/8-inch diameter at 12-foot span.
 9. 14 to 16-inch NPS: 1-inch diameter at 12-foot span.
 10. 18 to 20-inch NPS: 1 1/4-inch diameter at 12-foot span.
 11. 22 to 24-inch NPS: 1 1/2-inch diameter at 12-foot span.
- B. Copper Piping: Install hangers for drawn-temper copper piping with the following minimum rod sizes and maximum spacing:
 1. 1 1/4-inch NPS and smaller: 3/8-inch diameter at 5-foot span.
 2. 1 1/2 to 2-inch NPS: 3/8-inch diameter at 8-foot span.
 3. 2 1/2-inch NPS: 1/2-inch diameter at 9-foot span.
 4. 3-inch NPS: 1/2-inch diameter at 10-foot span.
 5. 4-inch NPS: 5/8-inch diameter at 10-foot span.
- C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

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- D. Support vertical runs at roof, at each floor, and at 8-foot intervals between floors.

END OF SECTION

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SECTION 23 05 53 – HVAC SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes equipment, pipe and duct labels and tags.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. Product Data: For each type of product indicated.
 - 2. Samples: For color, letter style, and graphic representation required for each identification material and device.
- B. Close-Out Submittals:
 - 1. Valve Schedules: For each piping system to include in maintenance manuals.

1.3. COORDINATION

- A. Coordinate the identification requirements with the Owner's up-to-date standards prior to purchasing materials.
- 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 locations of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1. EQUIPMENT LABELS

- A. Plastic Labels for Equipment: 1/8-inch multilayer, multicolor, plastic labels for mechanical engraving suitable for temperatures up to 160 deg F with pre-drilled holes for stainless steel rivets or self-tapping screws. Labels shall be minimum 2-1/2 inches wide and 3/4-inch tall with 3/8-inch white letters on black background.
 - 1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's drawing designation or unique equipment number.

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2.2. WARNING SIGNS AND LABELS

- A. Warning Signs and Labels: 1/8-inch multilayer, multicolor, plastic labels for mechanical engraving suitable for temperatures up to 160 deg F with pre-drilled holes for stainless steel rivets or self-tapping screws. Labels shall be minimum 2-1/2 inches wide and 3/4-inch tall with 3/8-inch letters.
 - 1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3. PIPE LABELS

- A. Pipe Labels: Pre-printed, color-coded, self-adhesive vinyl labels with lettering and flow direction arrows. They shall have minimum 1 1/2-inch tall block lettering. The labels shall be suitable for temperatures up to 160 deg F and compatible with each substrate material.

2.4. DUCT LABELS

- A. Duct Labels: Pre-printed, color-coded, self-adhesive vinyl labels with lettering and flow direction arrows. They shall have minimum 1 1/2-inch tall block lettering. The labels shall be suitable for temperatures up to 160 deg F and compatible with each substrate material.

2.5. STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; 3/4-inch for rated penetrations, and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions. Stencil paint shall be exterior, gloss, acrylic enamel.

2.6. VALVE TAGS

- A. Valve Tags: 0.032-inch thick brass or 0.025-inch thick stainless steel, stamped or engraved, with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers with pre-drilled or stamped holes for beaded chain or S-hook attachment hardware.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.7. CEILING TAGS

- A. Ceiling Tags: 0.030-inch thick and 3/4 to 7/8-inch diameter rigid vinyl, self-adhesive, plastic tags with pre-printed, minimum 1/8-inch tall block-letter text indicating the service, equipment, valve or accessory tag and number designations.

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2.8. WARNING TAGS

- A. Warning Tags: 5-1/4 inches wide and 3-inches tall, pre-printed or partially pre-printed, accident-prevention tags, of plasticized card stock with matte finish suitable for writing, fastened with reinforced grommet and wire. Tags shall have letters with large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

2.9. SENSOR TAGS

- A. Sensor Tags: 1/4-inch wide, pre-printed, clear vinyl adhesive tags with 1/8-inch tall block-letter black text. Each sensor shall be clearly and neatly labelled. Tags shall denote the associated piece of equipment, for example "TU-123".

PART 3 - EXECUTION

3.1. PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.2. JACKET COLOR

- A. Piping and Piped Equipment Insulation Jacket: Paint or provided pre-colored jacketing for all piping system insulation jacket meeting the requirements of this section.
 - 1. P/M/E Equipment Rooms: Color per System Identification Schedule.
 - 2. Exposed-to-View: Color per System Identification Schedule.
 - 3. Exposed-to-View: Flat Black.
 - 4. Concealed: Not required.
 - 5. Concealed: Color per System Identification Schedule.
- B. Duct and Ducted Equipment Insulation Jacket: Paint or provided pre-colored jacketing for all duct system insulation jacket meeting the requirements of this section.
 - 1. PME Equipment Rooms: Color per System Identification Schedule.
 - 2. PME Equipment Rooms: Not required.
 - 3. Exposed-to-View: Flat Black.
 - 4. Exposed-to-View: Not required.
 - 5. Concealed: Not required.

3.3. PIPE LABEL INSTALLATION

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- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4. EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment. Equipment to be labelled includes but is not limited to:
 - 1. Air handling equipment, including AHU, BCU, FCU, RTU, DOAS, ERU, CRAC, etc.
 - 2. Fans.
 - 3. Hydronic equipment, including pumps, water treatment, tanks and separators.
 - 4. Boilers.
 - 5. Chillers.
 - 6. Unit heaters.
 - 7. Carbon Monoxide monitors.
 - 8. Emergency Stop Switch
 - 9. Control panels and main sensors.
 - 10. Variable speed controllers, motor starters and disconnects.
 - a. Coordinate labeling with Division 26.
- B. Central HVAC system equipment labels shall include capacity and design information. Submit proposed label information for Engineer approval. The following are examples:
 - 1. Boilers
 - BOILER B-1
 - INSTALLED: JUNE 2030
 - OUTPUT: 1600 MBH

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INPUT: 2000 MBH
HHW FLOW: 160 GPM
HHW TEMPS: 160F / 180F

2. Fans

EXHAUST FAN EF-1
INSTALLED: JUNE 2030
SERVICE: ROOM 201 FUME HOOD
CAPACITY: 500 CFM at 0.5" ESP

- C. Locate equipment labels where accessible and visible.
- D. Equipment Color Schedule: Insulation color and label scheme shall match the associated piping system.

3.5. DUCT LABEL INSTALLATION

- A. Duct Labels: Install self-adhesive duct labels with permanent adhesive on air ducts.
 - 1. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6. VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.7. CEILING TAG INSTALLATION

- A. Install ceiling tags on lay-in grid and access doors below equipment, valves and accessories above finished ceilings. Center tags on grid members and doors.

3.8. WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9. SENSOR TAG INSTALLATION

- A. Install sensor tags for wall or ceiling-mounted sensors on faceplates centered below the device. Install sensor tags for concealed sensors on sensor enclosures or backboxes. Where

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sensors are located above lay-in ceilings, behind access doors, or otherwise remotely accessible, label the grid or door in addition to the device itself. Tags shall be centered and neatly applied.

3.10. RATED PENETRATION INSTALLATION

- A. Stencil penetration ratings and UL detail numbers on wall surfaces directly adjacent to the penetrations. UL detail number shall match the material used. This information shall be readily visible in non-occupied spaces, within chases and above ceilings. The following is an example:

2-HR RATED FIRE BARRIER
UL DETAIL SYSTEM NO. ABC-0000

3.11. SYSTEM IDENTIFICATION SCHEDULE

- A. Install equipment, piping and duct identification materials with the color and abbreviations that match the Owner's standard practice. Refer to System Identification Schedule below.

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SYSTEM IDENTIFICATION SCHEDULE			
PIPING SYSTEMS	ABBREV.	BACKGROUND	LETTERING
CHILLED WATER	CHWS/CHWR	DARK BLUE	WHITE
CONDENSER WATER	CDWS/CDWR	LIGHT BLUE	WHITE
DUAL TEMPERATURE WATER	DTWS/DTWR	PURPLE	WHITE
ENERGY RECOVERY GLYCOL	ER	BRIGHT BLUE	WHITE
REFRIGERANT	REF	WHITE	BLACK
DOMESTIC WATER	DCW/DHW/DHWR	GREEN	WHITE
NON-POTABLE WATER	NPW	LIGHT GRAY	WHITE
CONDENSATE DRAIN	CD	WHITE	BLACK
HEATING WATER	HWS/HWR	DARK RED	WHITE
HPS STEAM / CONDENSATE RETURN	HPS/HCR	ORANGE	BLACK
MPS STEAM / CONDENSATE RETURN	MPS/MCR	ORANGE	BLACK
LPS STEAM / CONDENSATE RETURN	LPS/LPR	ORANGE	BLACK
PUMPED CONDENSATE RETURN	PCR	ORANGE	BLACK
BOILER FEED WATER	BFW	DARK GRAY	WHITE
FIRE PROTECTION	FIRE	BRIGHT RED	WHITE
NATURAL GAS	NG	YELLOW	BLACK
PROPANE GAS	LPG	YELLOW	BLACK
FUEL OIL	FO	YELLOW	BLACK
DIESEL FUEL	DIESEL	YELLOW	BLACK
OTHERS	SEE PLANS	WHITE	BLACK
VALVE TAGS		BRASS	BLACK
EQUIPMENT AND DUCT SYSTEMS	ABBREV.	BACKGROUND	LETTERING
GENERAL BUILDING AIR	SA/RA/EA/OA	WHITE	BLACK
HAZARDOUS EXHAUST	SEE PLANS	SAFETY YELLOW	BLACK
WARNING SIGNS	SEE PLANS	SAFETY YELLOW	BLACK
CEILING GRID MARKERS	SEE PLANS	CLEAR	BLACK
EQUIPMENT TAGS	SEE PLANS	BLACK	WHITE

NOTE: PROVIDE FLOW ARROWS ON ALL DUCT AND PIPE MARKERS.

END OF SECTION

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SECTION 23 05 55 – HVAC PIPING SYSTEMS FLUSHING AND TESTING

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes requirements for HVAC piping system flushing and testing.

1.2. SUBMITTALS

- A. Delegated Design Submittals:
 - 1. Flushing and Testing Plan: Submit a Flushing and Testing Plan for review and approval of the Engineer. The plan shall include proposed use of building and temporary equipment; extent of piping system to be flushed and tested in each phase, if not performed all at once; source of water; disposal of water; flow rates; temporary bypass details and chemicals; etc.
- B. Product Submittals: For each type of product indicated include rated capacities, operating characteristics, and furnished specialties and accessories.
- C. Construction Submittals:
 - 1. Flushing and Testing Field Reports: For each section of piping that is independently flushed and tested, provide a letter to the Engineer certifying that the flushing and testing was performed in accordance to the requirements; documenting the failures and corrective actions; and recording the final results. Each letter shall be signed and dated by the Mechanical Contractor's Representative who performed the tests and the General Contractor's Representative who witness the tests certifying the piping system is clean and leak-free. A plan of the piping systems with sections flushed and tested highlighted shall be attached to each letter. The flushing and testing schedule shall be coordinated with the Owner and Engineer.
- D. Close-Out Submittals:
 - 1. Flushing and Testing Summary: Submit a copy of the Flushing and Testing Plan with any changes required by field conditions; a copy of each Flushing and Testing Field Report; and a Final Flushing and Testing Field Report that certifies that all applicable sections of each piping system have been satisfactorily completed.

PART 2 - PRODUCTS

2.1. TEMPORARY EQUIPMENT AND MATERIALS

- A. Provide all temporary equipment and materials required to perform the flushing and testing procedures.

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- B. Circulation pumps shall be sized and equipped with a variable speed drive and a flow meter so that the minimum flow velocity of 6 feet/second can be maintained in all tested pipe sizes. Use each pipe size's interior diameter to calculate the minimum flow rate in gallons/minute to determine the equivalent velocities.
- C. Temporary materials shall match the permanent materials unless a substitution is approved by the Engineer.
 - 1. Exception: Stainless steel corrugated flexible hoses with stainless steel braided covers rated for pressures in excess of the test pressures may be used for 2-inch and smaller temporary piping bypasses. Hoses must be free of kinks and sharp bends that could prevent proper circulation or restrict flushing of debris.

PART 3 - EXECUTION

3.1. TEMPORARY CONNECTIONS

- A. Heating and Cooling Equipment: At each heating and cooling equipment connection, provide a bypass to isolate the equipment and associated control and balancing valves from the piping.
 - 1. Upon completion of the piping mains and branches up to and including the equipment isolation valves; prior to installing the equipment control and balancing valve assemblies; and prior to installing the pipe insulation, install temporary bypass piping from the supply to the return branches. The bypass shall be of the same size and material as the branch piping. When open, the isolation valves shall allow the flushing and testing procedures. When closed, the isolation valves shall allow the bypass piping to be removed without exposing the completed piping sections.
 - 2. Upon acceptance of piping section, remove the temporary bypasses and complete installation of equipment valve assemblies and equipment connections.
- B. Maintain isolation between accepted and unaccepted piping at all times. If accepted piping is exposed to water circulated through unaccepted piping or any other dirt and debris, then the affected sections shall be re-flushed and tested as determined by the Engineer.
- C. If accepted piping is modified, then the affected sections shall be re-flushed and tested.

3.2. HYDRONIC PIPING SYSTEM FLUSHING AND TESTING PROCEDURES

- A. Prior to start, verify weld inspections and testing is complete as required in Section 230100.
- B. Initial Flushing:
 - 1. Install temporary equipment and piping required to perform flushing.
 - 2. Fill piping system with clean water and vent air.
 - 3. Install initial basket screens in circulation pump strainer. Circulate water and clean out strainer periodically until the initial basket screen remains clean for 30 minutes

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minimum. Insert final fine grit basket screen. Circulate water and clean out strainer periodically until the final basket screen remains clean for 30 minutes minimum.

4. Upon completion of initial flushing, drain water to sanitary sewer and replace strainer basket screens.

C. Pressure and Leak Testing:

1. Conduct pressure and leak testing after the initial flushing and prior to the final flushing of the system.
2. Conduct pressure and leak testing prior to insulating the piping.
3. Prior to testing, verify the maximum test pressure and duration of piping system components with their manufacturer. Do not test piping systems at pressures and durations in excess of the manufacturer's recommendations.
4. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
 - a. Leave joints, including welds, uninsulated and exposed for examination during test.
 - b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - c. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - d. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - e. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
 - f. Fill piping system with clean water.
 - g. Remove air from the piping using air vents at all high points in the system. Where air vents have not been installed yet because the final high point will be a part of the equipment valve assembly and connection piping, install manual air vent at the highest point in the temporary bypass piping.
 - h. Isolate expansion tanks and determine that hydronic system is full of water.

D. Perform the following tests on hydronic piping:

1. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's maximum working pressure but not less than 100 psig. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - a. Refer to Section 232113 and 232133 for hydronic and makeup water piping system operating pressures.

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2. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks and repeat hydrostatic test until there are no leaks for a continuous 2 hours.
 - a. Verify the test pressure does not drop over the duration of the test. Do not perform tests when the ambient temperature rises or drops enough to affect the test pressure.
 - b. If the piping fails, identify the leakage points, cut out the non-compliant sections and replace them with new materials. Do not attempt to patch, epoxy or caulk leaks.
 3. Record results.
 4. Upon completion of testing, drain water to sanitary sewer. Use drains installed at low points for complete draining of test liquid.
 5. Prepare written report of testing.
 6. Upon completion of testing, insulating work may begin.
- E. Cleaning and Final Flushing:
1. Fill piping system with clean water and vent air.
 2. Add pre-cleaning chemical solution designed to remove construction deposits such as pipe dope, oils, loose scale and other materials at manufacturer's recommended ratios. Circulate for 4 hours minimum and drain to sanitary sewer. Refill and re-flush until the system water is within the following tolerances of the makeup (utility service) water:
 - a. Alkalinity: within 0.3 pH of city water
 - b. Conductivity: 20 micro-ohms
 - c. No visible signs of cleaner or contaminants.
 - d. System shall be tested by owner chemical treatment service contractor prior to proceeding with chemical treatment.
 3. Fill piping system with clean water and vent air.
 4. Add cleaning solution diluted at manufacturer's recommended ratios to effectively clean the piping surfaces but avoid decay of the surface materials. Cleaners with trisodium phosphate are prohibited. Neutralizer agents as recommended by the cleaner manufacturer shall be used.
 5. Circulate water and clean out strainer periodically until the basket screen remains clean for 24 hours minimum.
 6. Upon completion of final flushing and cleaning, drain water to sanitary sewer.
 7. Refill with clean water, vent air and circulate water for 1 hour minimum. Drain water to sanitary sewer.
 8. Refill with clean water and treat per Section 232500.
 - a. If the piping will be isolated from the system for more than 7 days, add corrosion inhibitor, NALCO 3DT279 or equal.

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- b. If the piping system will be connected to a central utility distribution system, then coordinate the final fill and chemical treatment with the Owner.
- 9. Remove temporary equipment and piping.

END OF SECTION

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SECTION 23 05 93 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes testing, adjusting and balancing (TAB) of building systems.

1.2. GENERAL DESCRIPTION

- A. HVAC Air Systems:
 - 1. Measuring and testing of existing HVAC air systems to remain including outside air prior to the start of work to determine the existing baseline performance.
 - 2. TAB of new HVAC air systems including supply, return, exhaust, relief and outside air to design requirements.
- B. HVAC Piping Systems:
 - 1. TAB of new HVAC piping systems including heating and chilled water to design requirements.
- C. HVAC Control Systems:
 - 1. Verify new HVAC control systems.

1.3. SUBMITTALS

- A. Qualification Submittals:
 - 1. Qualification Data: Within 30 days of the Notice to Proceed, submit documentation that the TAB contractor and the project's TAB team members meet the qualifications specified in "Quality Assurance".
 - 2. Instrument calibration reports, to include the following: instrument type and make; serial number; application; dates of use; and dates of calibration.
- B. Product Submittals: For each type of product indicated.
- C. Construction Submittals:
 - 1. Initial certified TAB reports of individual systems for engineer's review.
 - 2. Commissioning Agent Certification: Provide owner's commissioning agent's certification that TAB measurements have been sampled and are considered accurate.
- D. Close-Out Submittals: Final certified TAB report with all systems in a single report.

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1.4. QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB).
 - 1. TAB Field Supervisor: TAB contractor employee who is certified by AABC or NEBB.
 - 2. TAB Technician: TAB contractor employee who is certified by AABC or NEBB.
- B. TAB Conference: Meet with engineer, owner, construction manager, owner's commissioning agent and related sub-contractors regarding the approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide 30-day notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB Plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. TAB Certification: Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard AABC or NEBB report forms as reviewed by the engineer.
- E. TAB Instrumentation: Provide instrumentation certification report including equipment type and make, serial number, accuracy and calibration as described in ASHRAE-111, Section 5, "Instrumentation."
 - 1. All instruments shall be calibrated within 6 months of use.
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing" and ASHRAE 90.1, Section 6.7.2.3 - "System Balancing".
- G. Code and AHJ Compliance: Comply with governing codes and requirements of authorities having jurisdiction.

1.5. PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

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1.6. COORDINATION

- A. Notice: Provide 10-day notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and hydronic systems have been satisfactorily completed. Alterations of the systems due to incomplete or non-conforming work made after testing will void previous TAB results and require new testing at no additional cost to the owner or engineer. Verify related work is complete before starting.
 - 1. Duct pressure tested without duct accessories such as dampers and access doors installed is not valid.

1.7. WARRANTY

- A. Balancing shall be warrantied for one year from date of Owner Acceptance.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

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AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design."
Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, di-verting, or mixing air flows.
- Q. 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.

3.2. PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures including a list of each piece of equipment and system.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. General:
 - a. Permanent electrical-power wiring is complete.
 - b. Automatic temperature-control systems are operational.
 - c. Equipment and duct access doors are securely closed.
 - d. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - e. Windows and doors can be closed so indicated conditions for system operations can be met.
 - 2. HVAC Air Systems:

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- a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
3. HVAC Piping Systems:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning in accordance with the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Suitable access to balancing devices and equipment is provided.

3.3. GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE-111 and in this Section.
 - 1. Comply with requirements in ASHRAE-62.1, Section-7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300.

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2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to specifications.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4. GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Coordinate pullies and sheaves needed to balance applicable air systems with fan supplier. Refer to Section 233400.
- E. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- F. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling-unit components.
- M. Verify that air duct system is sealed as specified.

3.5. PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:

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- a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

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- E. Verify final system conditions:
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.6. PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Single-Zone, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Balance variable-air-volume systems the same as described for constant-volume air systems.
 - 2. Set supply fan at minimum airflow if minimum airflow is indicated. Minimum airflow shall be not be below the minimum airflow requirements of the system for proper operation.
 - 3. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 - 4. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - 5. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7. GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.

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- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

3.8. PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design flow.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.

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- d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
- e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to re-duce excess throttling.
3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- G. Verify that memory stops have been set.

3.9. PROCEDURES FOR MOTORS

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- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10. PROCEDURES FOR HYDRONIC COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.

3.11. DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.12. PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

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3.13. HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing and the BAS Controls Contractor, perform the following:
 - 1. Verify HVAC control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents. Verify each control sequence of operation line-by-line including the operation of all equipment, valves dampers, etc.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14. TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent.
 - 3. Heating Water Flow Rate: Plus 10 percent or minus 5 percent.
 - 4. Cooling Water Flow Rate: Plus 10 percent or minus 5 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15. FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.

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3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents, including indicated versus final performance; notable characteristics of systems; and description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor, return, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - f. Variable speed controller settings.
 - g. Settings for pressure controller(s).

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- h. Other system operating conditions that affect performance.
- 15. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.

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- c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Inlet and discharge static pressure in inches wg.
 - e. Profile of internal pressure losses across each internal component, for example: fan, cooling coil, heating coil, filters, dampers, etc.
 - 1) Exception: Profiles are not required for air handling equipment with capacities of 5,000 cfm and smaller.
 - f. For each filter bank, filter static-pressure differential in inches wg.
 - g. Preheat-coil static-pressure differential in inches wg.
 - h. Cooling-coil static-pressure differential in inches wg.
 - i. Heating-coil static-pressure differential in inches wg.
 - j. List for each internal component with pressure-drop, static-pressure differential in inches wg.
 - k. Outdoor airflow in cfm.
 - l. Return airflow in cfm.
 - m. Outdoor-air damper position.
 - n. Return-air damper position.
- F. Apparatus-Coil Test Reports:
- 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.

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- g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:

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- a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System fan and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.

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- b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

3.16. INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing is complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Perform the inspection in the presence of the owner's commissioning agent.
- 3. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the contract documents in the final report.

B. Final Inspection:

- 1. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the engineer.
- 2. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

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4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, owner may contract the services of another TAB contractor to complete TAB work according to the contract documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

END OF SECTION

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SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes insulation of indoor and outdoor supply, return, exhaust, relief and ventilation duct systems.

1.2. ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3. QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
 - 2. Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

1.4. DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Storage: Insulation material shall be stored in a dry location sealed in plastic to prevent moisture infiltration. Insulation material, installed or not, that becomes wet, dirty, etc. shall be removed and replaced. "Dried" or "cleaned" insulation materials shall not be used.

1.5. COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with duct installer for duct insulation application. Before preparing ductwork shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6. SCHEDULING

- A. Schedule insulation installation after pressure testing duct systems. Application may begin on segments that have satisfactory test results. Insulation applied prior to satisfactory test results shall be removed and replaced.

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PART 2 - PRODUCTS

2.1. INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290. Provide Type II with factory-applied vinyl jacket; Type III with factory-applied FSK jacket; or Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. R-value requirements defined in Part 3 of this section as based on installed ratings with 25 percent compression.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2. ADHESIVES, MASTICS AND SEALANTS

- A. Adhesives, mastics and sealants shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Adhesives, mastics and sealants for indoor applications shall comply with low-VOC requirements of Section 230100.
- C. Adhesives:
 - 1. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 2. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- D. Mastics shall comply with MIL-PRF-19565C, Type II.
 - 1. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
- E. Sealants:
 - 1. FSK and Metal Jacket Flashing Sealants
 - 2. ASJ Flashing Sealants and Vinyl Flashing Sealants

2.3. FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

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1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4. FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Woven Glass-Fiber Fabric Jacket: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

2.5. TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

2.6. SECUREMENTS

- A. Insulation Pins and Hangers:
 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

2.7. CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3. GENERAL INSTALLATION REQUIREMENTS

- A. Insulate all components of duct systems as specified with the exception of the following components:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with thermal resistance requirements.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.
- B. Provide rigid board insulation strips at duct supports to avoid compression of duct wrap.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

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- D. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- F. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- G. Install multiple layers of insulation with longitudinal and end seams staggered.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

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- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4. PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- D. Insulation Installation at Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Seal penetrations through fire-rated assemblies.

3.5. INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

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- d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap un-faced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

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- d. Do not over-compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6. FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
- 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.7. FINISHES

- A. Paint duct insulation with ASJ, glass-cloth, or other paintable jacket material. Color shall be selected by the Owner/Engineer. Refer to Section 230553.
- 1. Prime with 2 coats of water-based white acrylic primer paint designed for use with associated jacket material.
 - 2. Finish with 2 coats of flat latex paint with fungicidal agent additive to render fabric mildew proof.
 - 3. Do not field paint aluminum or stainless-steel jackets.
- B. Apply paint and primer at the recommended spreading rate and film thickness as recommended by the paint manufacturer.

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- C. Apply paint and primer within the environmental conditions recommended by the paint manufacturer but not less than 55 deg F; not more than 90 deg F; and not more than 70 percent RH.

3.8. INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. General Building Duct Systems

- 1. Concealed single-wall duct shall be insulated as follows:
 - a. Supply and Ventilation Air: 2-inches (R-6) of mineral fiber blanket.
 - b. Return and Relief Air: None.
 - c. General Building Exhaust Air: None.
- 2. Exposed-to-view single-wall rectangular duct shall be insulated as follows:
 - a. Supply and Ventilation Air: 2-inches (R-6) of mineral fiber board.
 - b. Return and Relief Air: None.
 - c. General Building Exhaust Air: None.
- 3. Exposed-to-view single-wall round or flat-oval duct shall be insulated as follows:
 - a. Supply and Ventilation Air: 2-inches (R-6) of mineral fiber blanket.
 - b. Return and Relief Air: None.
 - c. General Building Exhaust Air: None.
- 4. Concealed or exposed-to-view double-wall duct shall have interstitial insulation as follows:
 - a. Supply and Ventilation Air: 2-inches (R-6) of mineral fiber blanket.
 - b. Return and Relief Air: None.
 - c. General Building Exhaust Air: None.
- 5. Concealed or exposed-to-view single-wall duct in unconditioned spaces shall be insulated as follows. Unconditioned spaces include attics, crawl spaces, and unheated mechanical rooms. They do not include vertical shafts surrounded by conditioned spaces.
 - a. Supply and Ventilation Air: 2-inches (R-6) of mineral fiber blanket.
 - b. Return and Relief Air: 2-inches (R-6) of mineral fiber blanket.
 - c. General Building Exhaust Air: None.

B. Plenums

- 1. Plenums connected to outdoor louvers or hoods shall be insulated as follows:
 - a. Ventilation Air: 3-inches (R-8) of mineral fiber board.
 - b. Exhaust/Relief Air: 2-inches (R-6) of mineral fiber board.
- 2. Plenums not connected directly to the outdoors shall be insulated as follows:
 - a. Supply Air: 2-inches (R-6) of mineral fiber board.

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- b. Ventilation Air: 3-inches (R-8) of mineral fiber board.
- c. Exhaust/Relief Air: 2-inches (R-6) of mineral fiber board.
- 3. Acoustic Plenums and Duct Silencers: Interior or interstitial duct liner shall have the same or greater thermal resistance as the systems they are attached as indicated above.

3.9. INDOOR FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. General Building Duct Systems
 - 1. Concealed single-wall insulated duct jacket: None.
 - 2. Concealed or exposed-to-view double-wall duct jacket: None.
- C. Plenums
 - 1. Single-wall insulated plenum jacket: 0.032-inch thick stucco embossed aluminum.

END OF SECTION 23 07 13

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SECTION 23 07 19 – PIPING AND PIPED EQUIPMENT INSULATION

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes insulation of HVAC piping systems:

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.3. QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Indoors installed in air plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Indoors not installed in air plenums: Flame-spread index of 25 or less, and smoke-developed index of 450 or less.
 - 3. Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 450 or less.

1.4. DELIVERY, STORAGE AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Storage: Insulation material shall be stored in a dry location sealed in plastic to prevent moisture infiltration. Insulation material, installed or not, that becomes wet, dirty, etc. shall be removed and replaced. "Dried" or "cleaned" insulation materials shall not be used.

1.5. COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with piping installer for piping insulation application. Before preparing piping shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

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- C. Coordinate installation and testing of heat tracing.

1.6. SCHEDULING

- A. Schedule insulation installation after pressure testing systems and where required after installing and testing heat tracing. Insulation applied prior to satisfactory test results shall be removed and replaced.

PART 2 - PRODUCTS

2.1. INSULATION MATERIALS

- A. General: Comply with requirements in Piping Insulation Schedule and Field-Applied Jacket Schedule articles for where insulating materials shall be applied.
 - 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
 - 2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
 - 3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
 - 4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
 - 5. Fitting Covers: Field apply insulation to cover valves, elbows, tees, and flanges.
- B. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 deg F Materials: Mineral wool or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Johns Manville Micro-Lok, Owens Corning Fiberglas or Engineer approved equal.
 - 2. Type II, 1200 deg F Materials: Mineral wool or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Owens Corning Thermafiber or Engineer approved equal.
 - 3. Thermal conductivity (k-value) maximum value of 0.34 BTU in /(hr sqft deg F) for fluid temperatures above 350 deg F; 0.32 for fluids 350 deg F and lower; 0.30 for fluids 250 deg F and lower; 0.29 for fluids 200 deg F and lower; 0.27 for fluids 60 deg F and lower; and 0.26 for fluids 40 deg F and lower.
- C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Armacell AP Armaflex or Engineer approved equal.
 - 1. Thermal conductivity (k-value) maximum value of 0.15 BTU in /(hr sqft deg F) for fluid temperatures 60 deg F and lower

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- D. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation with factory-applied ASJ-SSL. Johns Manville Trymer or Engineer approved equal.
 - 1. Thermal conductivity (k-value) maximum value of 0.19 BTU in /(hr sqft deg F) for fluid temperatures 60 deg F and lower and 0.23 for fluids 40 deg F and lower.
 - 2. Provide Type V for insulation in exposed locations below 6 feet above finished floor, exterior locations, and other locations subject to damage. Provide Type IV for insulation in exposed locations above 6 feet above finished floor and concealed locations.
 - 3. Fabricate shapes according to ASTM C 450 and ASTM C 585.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells with factory-applied ASJ-SSL. Comply with ASTM C 552, ASTM C 450 and ASTM C 585. Owens Corning Foamglas or Engineer approved equal.
 - 1. Thermal conductivity (k-value) maximum value of 0.30 BTU in /(hr sqft deg F) for fluid temperatures 60 deg F and lower and 0.29 for fluids 40 deg F and lower.

2.2. FACTORY-APPLIED JACKETS

- A. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White outward facing, bleached kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing.

2.3. FIELD-APPLIED JACKETS

- A. Insulation system schedules indicate field-applied jackets for various applications. When field-applied jackets are indicated, comply with the following:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Moisture Barrier:
 - 1) Indoor Applications: 1.5-mil thick, heat-bonded polyethylene and kraft paper.
 - 2) Outdoor Applications: 3.0-mil thick polysurlyn.
 - 2. PVC Jacket: High-impact resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C, 20-mils thick.
 - a. Adhesive: As recommended by jacket material manufacturer.
 - b. Color: Select from manufacturer's available pre-colored options. Do not paint in the field. Color scheme shall comply with Section 230553.
 - c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

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- 1) 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.
3. Woven Glass-Fiber Fabric Jacket: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.
4. Underground Direct-Buried Jacket: 125-mil thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
5. Self-Adhesive Outdoor Jacket: 60-mil thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.4. INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.5. PIPING INSULATION INSTALLATION MATERIALS

- A. General: Adhesives, mastics and sealants shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated. Indoor applications shall comply with low-VOC requirements of Section 230100.
- B. Adhesives:
 1. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 2. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 3. ASJ Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 4. PVC Jacket Adhesive: Compatible with PVC jacket.
 5. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 6. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 7. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- C. Mastics: Comply with MIL-PRF-19565C, Type II.

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1. Vapor-Barrier Mastic: Water based, white, suitable for indoor use on below-ambient services with water-vapor permeance of 0.013 perm at 43-mil dry film thickness per ASTM E 96/E 96M, Procedure B; service temperature range of minus 20 to plus 180 deg F; and solids content of 58 percent by volume and 70 percent by weight per ASTM D 1644.
 2. Breather Mastic: Water based; white, suitable for indoor and outdoor use on above-ambient services with service temperature range of minus 20 to plus 180 deg F; water-vapor permeance of 1.8 perms at 0.0625-inch dry film thickness per ASTM F 1249; and solids content of 60 percent by volume and 66 percent by weight.
- D. Sealants:
1. Joint Sealants: Permanently flexible, white or gray, elastomeric sealant with service temperature range of minus 100 to plus 300 deg F.
 2. FSK and Metal Jacket Flashing Sealants: Fire and water-resistant, aluminum color, flexible, elastomeric sealant with service temperature range of minus 40 to plus 250 deg F.
 3. ASJ Flashing Sealants and Vinyl and PVC Jacket Flashing Sealants: Fire and water-resistant, white, flexible, elastomeric sealant with service temperature range of minus 40 to plus 250 deg F.
- E. Tapes:
1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 2. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 3. PVC Tape: Vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
- F. Securements:
1. Bands:
 - a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015-inch thick, 3/4-inch wide with wing seal.
 - b. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch thick, 3/4-inch wide with wing seal.
 2. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
 3. Wire: 0.062-inch soft-annealed, stainless steel.
 4. Insulation Pins and Hangers:
 - a. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.

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- b. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - c. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - d. Non-Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - e. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - f. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - g. Non-Metal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
5. Corner Angles:
- a. Aluminum Corner Angles: 0.040-inch thick, minimum 1 by 1-inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
 - b. Stainless-Steel Corner Angles: 0.024-inch thick, minimum 1 by 1-inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1. PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water, 60 deg F and lower:
 - 1. Indoor and Above-Grade Outdoor Piping:
 - a. Cellular Glass: 1 1/2-inches thick for 2 to 6-inches NPS.
 - b. Polyisocyanurate: 1 1/2-inch thick for 2 to 6-inches NPS.
 - c. Elastomeric: 1 1/2-inch thick for 3/4 to 2-inches NPS.
- B. Chilled Water, above 40 deg F:
 - 1. Indoor and Above-Grade Outdoor Piping:

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- a. Cellular Glass: 1 1/2-inches thick for 3/4 to 24-inches NPS.
- b. Polyisocyanurate: 1 1/2-inches thick for 3/4 to 24-inches NPS.
- C. Heating-Hot-Water Supply and Return, 200 deg F and below:
 - 1. Indoor and Above-Grade Outdoor Piping:
 - a. Mineral-Fiber: 1-1/2-inches thick for 3/4 to 1-1/2-inches NPS; 2-inches thick for 2 to 24-inches NPS.

3.2. FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Indoor Equipment and Piping Jacket:
 - 1. Concealed Piping: None.
 - 2. Exposed Piping:
 - a. Up to 6 feet above floor: 20 mils thick PVC.
 - b. Greater than 6 feet above floor: 20 mils thick PVC.
- C. Outdoor Equipment and Piping Jacket:
 - 1. Above Ground Piping: 0.032-inch thick stucco embossed aluminum.
 - 2. Equipment: 0.032-inch thick stucco embossed aluminum.

3.3. EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4. PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

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3.5. GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

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- a. For below-ambient services, apply vapor-barrier mastic over staples.
- 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.
- Q. Piping insulation shall be continuous and not interrupted by hangers and supports. Hangers shall include factory-fabricated galvanized steel insulation shields that comply with MSS-58. Insulation installed that encapsulates any part of the hanger shall be removed and reinstalled.

3.6. PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

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- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 230500 for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 230500.

3.7. PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

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insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations necessary to access components. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe

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insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.8. PUMP INSULATION INSTALLATION

- A. 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 centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
- B. Fabricate boxes from aluminum, at least 0.050 inch thick.
- C. 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.

3.9. INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

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2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.10. INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11. INSTALLATION OF MINERAL-FIBER INSULATION

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- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.12. INSTALLATION OF POLYISOCYANURATE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

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1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
 2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of polyisocyanurate insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.13. FIELD-APPLIED JACKET INSTALLATION

- A. Where cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof

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sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.14. FINISHES

- A. Paint pipe insulation with ASJ, cloth, or other paintable jacket material. Color shall be selected by the Owner/Engineer. Refer to Section 230553 – HVAC Systems Identification.
 - 1. Prime with 2 coats of water-based white acrylic primer paint designed for use with associated jacket material.
 - 2. Finish with 2 coats of flat latex paint with fungicidal agent additive to render fabric mildew proof.
 - 3. Do not field paint PVC, stainless-steel or other non-paintable jackets.
- B. Apply paint and primer at the recommended spreading rate and film thickness as recommended by the paint manufacturer.
- C. Apply paint and primer within the environmental conditions recommended by the paint manufacturer but not less than 55F; not more than 90F; and not more than 70% RH.
- D. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

END OF SECTION

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SECTION 23 21 13 – HYDRONIC PIPING

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes pipe and fitting materials and joining methods for above ground hydronic piping.

1.2. SUBMITTALS

- A. Delegated Design Submittals:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
- B. Qualification Submittals:
 - 1. Welding certificates.
 - 2. Pipe and fitting manufacturing source list confirming the materials will be products of the United States of America.
- C. Product Submittals: For each type of product indicated.

1.3. QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - a. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. All piping and fittings shall be products of the United States of America. All other piping and fittings will be removed from the project at the contractor's expense.

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1. This requirement does not apply to piping that is internal to and factory-fabricated and installed in unitary equipment. The requirement does apply to all field-installed piping and skid-mounted assemblies with factory-fabricated and installed piping.

PART 2 - PRODUCTS

2.1. PERFORMANCE REQUIREMENTS

- A. Hydronic piping and components shall be capable of withstanding the following working pressures and temperatures. Piping systems shall be pressure tested, leak tested and flushed according to Section 230555 based on these working pressures.
 1. Chilled Water Piping: 100 psig at 75 deg F.
 2. Heating (140 to 200 deg F) Water Piping: 100 psig at 250 deg F.
 3. Make-Up (Domestic) Water Piping: 80 psig at 75 deg F.

2.2. COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings and Unions: ASME B16.22.

2.3. STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53 or A 106, black carbon steel with plain ends; ERW electric resistance welded (Type E) or seamless (Type S), Grade B. Refer to Part 3 for applications.
 1. "Standard Weight" steel piping is not equal to Schedule 40 at 12-inches NPS and larger. Provide piping materials that comply with Part 3 of this section. The following are the minimum pipe thicknesses for each application:

STEEL PIPE WALL THICKNESSES			
NOMINAL PIPE SIZE (INCHES)	STD. WEIGHT WALL THICKNESS (INCHES)	SCHEDULE 40 WALL THICKNESS (INCHES)	SCHEDULE 80 WALL THICKNESS (INCHES)
3/4	0.113	0.113	0.154
1	0.133	0.133	0.179
1 1/4	0.140	0.140	0.191
1 1/2	0.145	0.145	0.200
2	0.154	0.154	0.218

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2 1/2	0.203	0.203	0.276
3	0.216	0.216	0.300
4	0.237	0.237	0.337
6	0.280	0.280	0.432
8	0.322	0.322	0.500
10	0.365	0.365	0.594
12	0.375	0.406	0.688
14	0.375	0.438	0.750
16	0.375	0.500	0.844
18	0.375	0.562	0.938
20	0.375	0.594	1.031
24	0.375	0.688	1.219

- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of material group 1.1, butt-welded end connections, and raised facings.
- H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4. PLASTIC PIPE AND FITTINGS

- A. CPVC plastic pipe shall be ASTM F 441/F 441M. CPVC plastic pipe fittings shall be socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe and ASTM F 439 for Schedule 80 pipe.
- B. PVC plastic pipe shall be ASTM D 1785. PVC plastic pipe fittings shall be socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe and ASTM D 2467 for Schedule 80 pipe.

2.5. JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, Grade B7, carbon steel, unless otherwise indicated.

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- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Solvent Cements for Joining Plastic Piping: CPVC piping solvent cements shall comply with ASTM F 493. PVC piping solvent cements shall comply with ASTM D 2564. Solvents shall be low VOC.
- G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6. DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating non-conductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions, 2-inches NPS and smaller: Factory-fabricated ASSE 1079 rated for 150 psig with solder-joint copper alloy and threaded ferrous end connections.
- C. Dielectric Flanges, 1 1/2 to 4-inches NPS: Factory-fabricated ASSE 1079 bolted, companion-flange assembly, rated for 150 psig with solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous end connections.
- D. Dielectric Nipples, 4-inches NPS and smaller: Factory-fabricated IAPMO PS 66 electro-plated steel nipple complying with ASTM F 1545, inert and non-corrosive propylene, rated for 300 psig, and threaded end connections

PART 3 - EXECUTION

3.1. PIPING APPLICATIONS

- A. Heating and Cooling Water Piping, Above Ground, 2-inches NPS and smaller:
 - 1. Steel Piping: Schedule 80, Type S, Grade B steel, Class 125 cast-iron or Class 150 malleable-iron fittings and threaded joints.
- B. Heating and Cooling Water Piping, Above Ground, 2 1/2-inches NPS and larger:
 - 1. Steel Piping: Schedule 40, Type E or S, Grade B steel, Class 150 wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and butt-welded and flanged joints.
- C. Heating and Cooling Water Piping, Below Slab:
 - 1. Copper Piping: Type K, annealed-temper ("soft") copper tubing, wrought-copper fittings, and soldered joints. No joints shall be located below grade.

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- D. Make-Up (Domestic) Water Piping, Above Ground:
 - 1. Copper Piping: Type L, drawn-temper (“hard”) copper tubing, wrought-copper fittings and soldered joints.
- E. Make-Up (Domestic) Water Piping, Below Slab:
 - 1. Copper Piping: Type K, annealed-temper (“soft”) copper tubing, wrought-copper fittings, and soldered joints. No joints shall be located below grade.
- F. Condensate Drain Piping:
 - 1. Copper Piping: Type DWV for 1 1/2-inch and larger piping and Type L for 1 1/4-inch and smaller piping, drawn-temper (“hard”) copper tubing, wrought-copper fittings and soldered joints.
- G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- H. Air-Vent Piping: Type K, annealed-temper (“soft”) copper tubing, wrought-copper fittings, and soldered joints.
- I. Safety-Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2. PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

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- L. Install drains, consisting of a tee fitting, line-size full port-ball valve, and short line-size nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
 - 1. Piping 6-inches NPS and smaller: 3/4-inch
 - 2. Piping 8 to 12-inches NPS: 1-inch
 - 3. Piping 14-inches NPS and larger: 2-inch
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow, except drain piping. For drain piping provide a uniform grade of 0.2 percent downward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Section 232119.
- Q. Install unions in piping, 2-inch NPS and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, 2 1/2-inch NPS and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230553 for identifying piping.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517.
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517.
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230100.
- X. Install pressure / temperature ports as indicated in the details and on the inlet and discharge side of each balancing and control valve.
- Y. Utilize wet taps or line stops to connect to existing active piping.

3.3. DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.4. HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

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- B. Comply with requirements in Section 230548 for seismic restraints.

3.5. PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Non-Pressure Piping: Join according to ASTM D 2855.

3.6. TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519.

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3.7. FIELD QUALITY CONTROL

- A. Inspect welds in accordance with Section 230100.
- B. Flush, leak test and pressure test piping in accordance with Section 230555.
- C. Perform the following before operating the system:
 - 1. Open manual valves fully.
 - 2. Inspect pumps for proper rotation.
 - 3. Set makeup pressure-reducing valves for required system pressure.
 - 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 - 5. Set temperature controls so all coils are calling for full flow.
 - 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 - 7. Verify lubrication of motors and bearings.

END OF SECTION

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SECTION 23 21 16 – HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes special-duty valves and specialties for hydronic piping systems.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.3. QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide specialty valves, air vents, tanks and strainers by the following, unless otherwise noted:
 - 1. Amtrol
 - 2. Armstrong
 - 3. Bell & Gossett
 - 4. TACO

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2.2. PRESSURE REDUCING VALVES

- A. Diaphragm-Operated, Pressure-Reducing Valves: Bronze or brass body diaphragm-operated pressure reducing valves with PTFE disc, brass seat, EPT diaphragm, EPDM O-ring stem seals, low inlet pressure check valve, inlet strainer that is removable without system shutdown and non-corrosive valve seat and stem and ASME labeled. Valve size, capacity and operating pressure shall be selected to suit system. Operating pressure and capacity shall be factory-set and field adjustable.

2.3. SAFETY RELIEF VALVES

- A. Diaphragm-Operated Safety Relief Valves: Bronze or brass body diaphragm-operated safety relief valves with PTFE disc, brass seat, EPT diaphragm, EPDM O-ring stem seals, brass and rubber internal wetted working parts, inlet strainer that is removable without system shutdown and non-corrosive valve seat and stem and ASME labeled. Valve size, capacity and operating pressure shall be selected to suit system. Operating pressure and capacity shall be factory-set and field adjustable.

2.4. HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers: Y-pattern strainer with cast-iron body, bolted cover and bottom drain connection; threaded end connections for 2-inch NPS and smaller and flanged for 2 1/2-inch and larger; medium-straining mesh stainless steel strainer screen; and rated for 125 psig CWP (cold working pressure).
- B. Basket Strainers: Basket strainers with cast-iron body, bolted cover and bottom drain connection; threaded end connections for 2-inch NPS and smaller and flanged for 2 1/2-inch and larger; fine-straining mesh stainless steel start-up strainer; medium-straining perforated stainless steel basket with 50-percent free area; and rated for 125 psig CWP (cold working pressure).
- C. Stainless-Steel Bellow Flexible Connectors: Flexible connector constructed of stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; capable of 3/8-inch misalignment; threaded end connections for 2-inch NPS and smaller and flanged for 2 1/2-inch and larger; and rated for 150 psig CWP (cold working pressure) and 250 deg F maximum operating temperature. Flexicraft FF/TT series or Engineer approved equal.
- D. Spherical-Rubber Flexible Connectors: Flexible connector constructed of fiber-reinforced rubber; capable of misalignment; Class 150 flanged end connections; and rated for 150 psig CWP (cold working pressure) and 250 deg F maximum operating temperature.
 - 1. Base-Mounted Pump Connections: Provide flexible connectors with galvanized elongation limiting cables. MetraFlex Cablesphere Series or Engineer approved equal.

2.5. ESCUTCHEONS AND FLOOR PLATES

- A. Escutcheons:
 - 1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

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2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
 3. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- B. Floor Plates:
1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 2. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1. VALVE APPLICATIONS

- A. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- B. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2. HYDRONIC SPECIALTIES INSTALLATION

- A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- B. Install piping from equipment to expansion tank with a 2 percent upward slope toward tank.
- C. Install coalescing-type air and sediment separator in pump suction with wye-type strainer immediately upstream. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- D. When indicated, install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 1. Install tank fittings that are shipped loose.
 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- E. When indicated, install expansion tanks on the floor. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.

3.3. ESCUTCHEONS AND FLOOR PLATES INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

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- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: Install one-piece cast-brass type for new piping installations. Install deep-pattern type where piping sleeve protrudes from the floor or wall.
 - 2. Existing Piping: Install split-casting brass type for existing piping installations.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.
- E. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

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SECTION 23 21 19 – HYDRONIC PIPING VALVES

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes general duty valves for HVAC piping systems such as angle, ball, butterfly, check, gate and globe valves and associated accessories.

1.2. SUBMITTALS

- A. Product Submittals: For each type of valve indicated.

1.3. QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.4. DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
 - 1. Apollo Valves / Conbraco
 - 2. Bray
 - 3. Crane Company / Crane Fluid Systems
 - 4. DeZurik
 - 5. Metso / Jamesbury and Neles
 - 6. Milwaukee Valve / Hammond Valve
 - 7. NIBCO
 - 8. Powell Valves
- B. Refer to HVAC valve schedule articles for applications of valves.
- C. Combination valves that combine multiple valve and specialty functions will not be accepted unless specifically noted.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves 6-inches NPS and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Hand Lever: For quarter-turn valves 4-inches NPS and smaller except plug valves.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height of 7-feet or higher.
 - 6. Valves shall be equipped with means to lock them closed in compliance with OSHA Lock-out / Tag-out procedure.
- G. Valves in Insulated Piping: Provide valves with 2-inch stem extensions for piping temperatures 180 deg F and lower and 4-inch for above 180 deg F.

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1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
- H. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Threaded: With threads according to ASME B1.20.1.
 3. Socket Welded: 2-inch NPS and smaller piping.
 4. Solder Joint: With sockets according to ASME B16.18. Use solder with melting point below 840 deg F, except for ball valves where the melting point shall be below 421 deg F.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.2. ANGLE VALVES

- A. Angle Valves, 2-inches NPS and smaller: Bronze body with integral seat and union-ring bonnet angle valves with bronze trim, PTFE or TFE seats and asbestos-free packing, Class 150 rated for 300 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-80. Valves shall have threaded or solder ends to match piping.
- B. Angle Valves, 2 1/2-inches NPS and larger: Iron body and bolted-bonnet angle valves with bronze trim, PTFE or TFE seats and asbestos-free packing, Class 125 rated for 200 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-85. Valves shall have flanged ends.

2.3. BALL VALVES

- A. Ball Valves, 2-inches NPS and smaller: Two-piece, full-port, quarter-turn, forged brass ball valves with stainless steel trim, PTFE or TFE seats, adjustable stem packing and anti-blowout stem, rated for 600 psig CWP (cold working pressure). Valves shall comply with MSS SP-110. Valves shall have threaded ends.

2.4. BUTTERFLY VALVES

- A. Butterfly Valves, 2 1/2-inches NPS and larger: Iron single-flange, cast-iron or ductile-iron butterfly valves with carbon steel disc, stainless steel stem, EPDM seat, rated for 150 psig CWP (cold working pressure). Valve body shall be lug type suitable for bi-directional dead-end service at rated pressure without the use of a downstream flange. Valves shall comply with MSS SP-67, Type I. Valves shall have flanged ends.

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- B. High-Performance Butterfly Valves, 2 1/2-inches NPS and larger: Single-flange, carbon-steel high-performance butterfly valves with carbon steel disc, stainless steel stem offset from seat plane, reinforced PTFE or metal seat, Class 150 rated. Valve body shall be lug type suitable for bi-directional dead-end service at rated pressure without the use of a downstream flange. Valves shall comply with MSS SP-68. Valves shall have flanged ends.

2.5. CHECK VALVES

- A. Lift Check Valves, 2-inches NPS and smaller: Bronze lift check valves for vertical flow with bronze disc and Class 125 rated for 200 psig CWP (cold working pressure). Valves shall comply with MSS SP-80. Valves shall have threaded ends.
- B. Center-Guided Check Valves, 2 1/2-inches NPS and larger: Center-guided spring-loaded globe type check valves with ductile iron body, EPDM or NBR seat, and Class 150 rated for 250 psig CWP (cold working pressure). Valves shall comply with MSS SP-125. Valves shall have flanged ends.

2.6. GATE VALVES

- A. Gate Valves, 2-inches NPS and smaller: Bronze rising-stem gate valves with integral seat and union-ring bonnet, bronze stem, solid-wedge bronze disc and asbestos-free packing and Class 150 rated for 300 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-80. Valves shall have threaded ends.
- B. Gate Valves, 2 1/2 to 12-inches NPS: Iron rising-stem gate valves with bolted-bonnet, bronze trim, solid-wedge disc and asbestos-free packing and Class 125 rated for 200 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-70. Valves shall have flanged ends.
- C. Gate Valves, 2 1/2 to 12-inches NPS: Iron OS&Y gate valves with bolted-bonnet, bronze trim, solid-wedge disc, asbestos-free packing and gasket, and Class 125 rated for 200 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-70. Valves shall have flanged ends.
- D. Gate Valves, 14-inches NPS and larger: Iron rising-stem gate valves with bolted-bonnet, bronze trim, solid-wedge disc and asbestos-free packing and Class 125 rated for 150 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-70. Valves shall have flanged ends.
- E. Gate Valves, 14-inches NPS and larger: Iron OS&Y gate valves with bolted-bonnet, bronze trim, solid-wedge disc, asbestos-free packing and gasket, and Class 125 rated for 150 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-70. Valves shall have flanged ends.

2.7. GLOBE VALVES

- A. Globe Valves, 2-inches NPS and smaller: Bronze body with integral seat and union-ring bonnet globe valves with bronze trim, PTFE or TFE seats and asbestos-free packing, Class 150 rated for 300 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-80. Valves shall have threaded ends.

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- B. Globe Valves, 2 1/2-inches NPS and larger: Iron body and bolted-bonnet globe valves with bronze trim, PTFE or TFE seats and asbestos-free packing, Class 125 rated for 200 psig CWP (cold working pressure). Hand-wheels shall be malleable or ductile iron. Valves shall comply with MSS SP-85. Valves shall have flanged ends.

2.8. MANUAL CALIBRATED BALANCING VALVES

- A. Manual Calibrated Balancing Valves: Armstrong CBV Series, Bell & Gossett Circuit Setter Plus Series, Griswold QuickSet Series or TACO Accu-Flo Series.
 - 1. Flow Verification: Provide a differential pressure versus flow calibration charts for use by the Engineer and TAB sub-contractor.
- B. Manual Calibrated Balancing Valves, 2-inches NPS and smaller: Manual balancing valve with bronze or copper-alloy body; calibrated ball or globe type orifice or venturi for flow control; brass or stainless ball; PTFE seat; two pressure gage connections with integral seals for portable differential pressure meter; drain tapping; and rated for 125 psig CWP (cold working pressure). Valve shall have hand lever shall have memory stop and integral pointer and calibrated scale to register the degree of valve opening. Valves shall have threaded ends.
- C. Manual Calibrated Balancing Valves, 2 1/2-inches NPS and larger: Manual balancing valve with cast or ductile-iron body; calibrated ball or globe type orifice or venturi for flow control; brass or stainless ball; PTFE seat; two pressure gage connections with integral seals for portable differential pressure meter; drain tapping; and rated for 125 psig CWP (cold working pressure). Valve shall have hand lever shall have memory stop and integral pointer and calibrated scale to register the degree of valve opening. Valves shall have flanged ends.

2.9. AUTOMATIC BALANCING VALVES

- A. Automatic Balancing Valves: Valves shall maintain constant flow within 5 percent, plus or minus, over system pressure fluctuations.
 - 1. Flow Verification: Provide electronic differential pressure meter that can read differential pressure including flowmeter, probes, hoses, flow charts and carrying case.
 - 2. Cartridge Exchange: For up to 1 year from acceptance of the final TAB Report, up to 10% of cartridges in the project may be replaced as needed for any reason as determined by the Engineer.
- B. Automatic Balancing Valves, 2-inches NPS and smaller: Combination automatic balancing valve and isolation valve with Y-pattern brass body; removable stainless steel flow cartridge; stainless steel spring; EPDM O-ring; two pressure and temperature ports; and rated for 175 psig CWP (cold working pressure). Isolation valve shall be quarter-turn ball valve with brass or stainless steel ball. Flow cartridge shall be stamped with flow rate. Flow Design (FDI) AutoFlow AC Series, Griswold Isolator R Series, Hays Mesurflo Series, Nexus Valve UltraMatic UM Series, or Victaulic 76 Series.
- C. Automatic Balancing Valves, 2 1/2-inches NPS and larger: Automatic balancing valve with wafer-style ductile-iron body; stainless steel flow cartridge; stainless steel spring; EPDM cartridge seal; two pressure and temperature ports; and rated for 200 psig CWP (cold working pressure). Flow Design (FDI) WS Series, Griswold Wafer Series or Nexus Valve UltraMatic UMW Series.

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2.10. CONTROL VALVES

- A. Comply with the requirements of Section 239010.

2.11. CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve.
 - 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. 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.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2. VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Install valves in branch lines to isolate sections of the piping system.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe. Valves with stems below center of piping are not acceptable.
- E. Install valves in position to allow full stem movement.
- F. Valves shall be equipped with stem extensions for all applications where the piping will be insulated.

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- G. Install chainwheels on operators for ball, butterfly, gate and globe valves 3-inches NPS and larger and more than 7-feet above floor. Extend chains to 60 inches above finished floor. Provide hooks to hold chains to the side to allow a clear walkway path.
- H. Install shut-off duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- I. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- J. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Wafer-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- K. Install balancing valves in the return pipe of each heating or cooling terminal.
- L. Install control valves in locations indicated in details and as needed to perform the sequence of operations.
- M. Install pressure / temperature ports as indicated in the details and on the inlet and discharge side of each balancing and control valve.

3.3. ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4. GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Hydronic piping systems shall use the following valve types unless otherwise indicated on the drawings or in other Division 23 sections:
 - 1. Shutoff: Ball or butterfly.
 - 2. Service Entrance Shutoff: High performance butterfly valves. Service entrance is defined as the entrance to a building from an underground distribution system or building branch connections to the mains of a centralized distribution system.
 - 3. Shutoff on heat exchangers served from centralized distribution systems on the source side and the first isolation valve, supply and return, on the building load side: High performance butterfly valves
 - 4. Throttling: Globe, ball or butterfly.
 - 5. Pump Discharge Check Valves: Lift check valves for 2-inches NPS and smaller. Non-slam, center-guided, globe type check valves for 2 1/2-inches NPS and larger.
 - 6. Balancing:
 - a. Two-Way Modulating, Pressure Independent Control Valves: None.

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- b. Two-Way Modulating, Pressure Dependent Control Valves: Automatic.
 - c. Two-Way Two-Position Pressure Dependent Control Valves: Automatic.
 - d. Three-Way Modulating Pressure Dependent Control Valves: Automatic.
 - e. Constant Speed Pumps: Manual-calibrated with balanced flow set point.
 - f. Boilers, Heat Exchangers, Chillers and Cooling Towers: Automatic.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

END OF SECTION

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SECTION 23 21 23 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes HVAC hydronic system pumps.

1.2. SUBMITTALS

- A. Product Submittals: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
 - 1. Proposed pump data shall include all potential motor sizes, impeller sizes, total head, flow rates and efficiency curves. Pump curves showing only the proposed selection point data is not acceptable.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.3. QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.4. 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. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

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2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Centrifugal Pumps:
 - a. Armstrong Pumps
 - b. Bell & Gossett
 - c. TACO
- B. Motors: Comply with requirements of Section 230513.
 - 1. Shaft Grounding Rings (SGR): Pump motors 5 hp and larger shall have solid or split type shaft grounding rings designed to prevent bearing damage due to adjustable speed drive induced currents. SGR shaft diameter shall match the motor's standard NEMA "u" dimension.

2.2. CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage-tappings at inlet and outlet, replaceable bronze wear rings and flanged connections.
 - 2. Impeller: Stainless steel Type 304; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel or carbon steel.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and ethylene propylene terpolymer (EPT) or ethylene propylene rubber (EPR) bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- C. Motor: Single speed and rigidly mounted to pump casing.

2.3. PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:
 - 1. Angle pattern.
 - 2. 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
 - 3. Strainer:

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- a. Closed-Loop Systems: Bronze fine-straining startup screen and stainless-steel medium-straining permanent screen strainers.
- 4. Bronze or stainless-steel straightening vanes.
- 5. Drain plug.
- 6. Factory-fabricated support.
- B. Triple-Duty Valve:
 - 1. Angle or straight pattern.
 - 2. 175-psig pressure rating, ductile-iron body, pump-discharge fitting.
 - 3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
 - 4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. PUMP INSTALLATION

- A. Comply with HI 1.4 and HI 2.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 1. Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.

3.3. ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.

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- B. Comply with requirements in Hydronics Institute (HI) standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. Use a laser-alignment tool and provide a report documenting the results of the final alignment within acceptable tolerances. Verify the alignments are within the manufacturer's recommended tolerances or the following maximums, whichever is stricter:
 - 1. Short Couplings:
 - a. Pumps at 1200 rpm: 3.0 mils (0.0030-inches) offset and 0.6 mils/inch angularity.
 - b. Pumps at 1800 rpm: 2.5 mils (0.0025-inches) offset and 0.4 mils/inch angularity.
 - c. Pumps at 3600 rpm: 1.5 mils (0.0015-inches) offset and 0.3 mils/inch angularity.
 - 2. Spacer Couplings:
 - a. Pumps at 1200 rpm: 1.1 mils/inch angularity.
 - b. Pumps at 1800 rpm: 0.8 mils/inch angularity.
 - c. Pumps at 3600 rpm: 0.4 mils/inch angularity.
- E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4. CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check, shutoff and throttling valves on discharge side of pumps not equipped with a variable speed drive. Install check and shutoff valves on discharge side of pumps equipped with a variable speed drive.
- E. Install suction diffuser and shutoff valve on suction side of base-mounted pumps and Y-type strainer and shutoff valve on suction side of in-line pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping or install single gage with multiple-input selector valve. A single differential pressure gage is not acceptable.
- H. Install check valve and gate or ball valve on each condensate pump unit discharge.
- I. Ground equipment according to Division 26 specifications.

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- J. Connect wiring according to Division 26 specifications.

3.5. STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.6. DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

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SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes single and double-wall round, oval and rectangular metal duct and fittings and associated sealants, gaskets, hangers and supports.

1.2. PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Delegated Outdoor Duct Support Design: Duct support construction shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and be suitable for outdoor conditions including attachment details and support and curb heights for snow and rain.
 - 1. Comply with Section 230548 for wind and seismic restraints.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE-62.1.

1.3. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. Shop Drawings: For all new ductwork and accessories.
 - a. Factory and shop-fabricated ducts and fittings.
 - b. Reinforcement and spacing.
 - c. Seam and joint construction.
 - d. Details for penetrations through fire-rated and other partitions.
 - e. Hangers and supports, including methods for duct and building attachment and vibration isolation.
 - f. Sheet metal thicknesses.
- B. Construction Submittals:
 - 1. Leakage Test Report: Documentation of work performed for compliance with ASHRAE 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."

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C. Close-Out Submittals:

1. As-Built Documents: Provide revised coordination drawings to match the installed conditions.

1.4. DEFINITIONS

- A. System Operating Pressure: Duct system operating pressure is equal to the scheduled external static pressure, unless otherwise noted.
1. Duct downstream of air terminal units, between terminal unit discharge and diffuser inlet, the operating pressure may be reduced to 1-inch w.g., unless otherwise noted.

PART 2 - PRODUCTS

2.1. SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations and other imperfections.
- B. Galvanized Steel Sheets: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation:
 - a. G60: Non-hazardous systems such as supply, return, ventilation, relief and general building exhaust duct installed indoors.
 2. Finishes for Surfaces Exposed-to-View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.2. DUCT CONSTRUCTION

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class with the following exceptions:
1. Minimum Sheet Metal Thickness:
 - a. Non-hazardous ducted systems including supply, return, ventilation, relief and general building exhaust air.

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- 1) Galvanized Sheet Steel: 0.028-inches (24-gage).
2. Minimum Construction Standards: Refer to the Table below for minimum construction standards in addition to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

METAL DUCT MINIMUM CONSTRUCTION STANDARDS

DUCT SYSTEMS	MAXIMUM OPERATING PRESSURE (+/- IN WG)	SMACNA DUCT PRESSURE CLASS. (+/- IN WG)	SMACNA SEAL CLASS (A, B or C)	SMACNA LEAKAGE CLASS (C _L)	LONGITUDINAL SEAM TYPES	TRANSVERSE JOINT TYPES	FITTING CONSTRUCTION
RECTANGULAR DUCT	1.0	1	B	8	L-1	T-1, 3, 6, 17, 19, 22, 24 (Note #3)	6, 7 and 8
	1.5	2	B	8	L-1	T-1, 3, 6, 17, 19, 22, 24 (Note #3)	6 and 7
	2.5	3	A	8	L-1	T-17, 19, 22 and 24 (Note #3)	6 and 7
	3.0	4	A	4	L-1	T-22 (Note #3)	6 and 7
	5.0	6	A	4	L-1	T-22 (Note #3)	6 and 7
	8.0	10	A	4	L-1	T-22 (Note #3)	6 and 7
ROUND DUCT WITH LONGITUDINAL SEAMS	1.0	1	B	8	RL-4, 5, 6A, 6B, 7 and 8	RT-1, 2, 3, 4, 5 and 6 (Note #4)	10 and 14
	1.5	2	B	8	RL-4 and 5	RT-1 and 2 (Note #4)	10, 11, 13 and 14
	2.5	3	A	4	RL-4 and 5	RT-2 (Note #4)	10, 11, 13 and 14
	3.0	4	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #4)	10, 11, 13 and 14
	5.0	6	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #4)	10, 11, 13 and 14
	8.0	10	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #4)	10, 11, 13 and 14
ROUND DUCT WITH SPIRAL SEAMS	1.0	1	B	8	RL-1 (Spiral)	RT-1 and 2 (Note #4)	10, 11, 13 and 14
	1.5	2	B	8	RL-1 (Spiral)	RT-2 (Note #4)	10, 11, 13 and 14
	2.5	3	A	4	RL-1 (Spiral)	RT-2 (Note #4)	10, 11, 13 and 14
	3.0	4	A	2	RL-1 (Spiral)	RT-2 (Note #4)	10, 11, 13 and 14
	5.0	6	A	2	RL-1 (Spiral)	RT-2 (Note #4)	10, 11, 13 and 14
	8.0	10	A	2	RL-1 (Spiral)	RT-2 (Note #4)	10, 11, 13 and 14
FLAT OVAL DUCT WITH LONGITUDINAL SEAMS	1.0	1	B	8	RL-4 and 5	RT-2 (Note #5)	12, 13 and 14
	1.5	2	B	8	RL-4 and 5	RT-2 (Note #5)	12, 13 and 14
	2.5	3	A	4	RL-4 and 5	RT-2 (Note #5)	12, 13 and 14
	3.0	4	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #5)	12, 13 and 14
	5.0	6	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #5)	12, 13 and 14
	8.0	10	A	2	RL-4 and 5 (Poss. Press. Only)	RT-2 (Note #5)	12, 13 and 14
FLAT OVAL DUCT WITH SPIRAL SEAMS	1.0	1	B	8	RL-1 (Spiral)	RT-1 and 2 (Note #5)	12, 13 and 14
	1.5	2	B	8	RL-1 (Spiral)	RT-2 (Note #5)	12, 13 and 14
	2.5	3	A	4	RL-1 (Spiral)	RT-2 (Note #5)	12, 13 and 14
	3.0	4	A	2	RL-1 (Spiral)	RT-2 (Note #5)	12, 13 and 14
	5.0	6	A	2	RL-1 (Spiral)	RT-2 (Note #5)	12, 13 and 14
	8.0	10	A	2	RL-1 (Spiral)	RT-2 (Note #5)	12, 13 and 14

NOTES:

1. REFER TO SMACNA 'HVAC DUCT CONSTRUCTION STANDARD - METAL AND FLEXIBLE' (2005) FOR SEAM, JOINT AND FITTING TYPES.
2. REFER TO SMACNA 'HVAC AIR DUCT LEAKAGE TEST MANUAL' (2012) FOR PRESSURE, SEAL AND LEAKAGE CLASSES.
3. FACTORY-FABRICATED SLIDE-ON CONNECTORS ALSO MAY BE USED, DUCTMATE TYPE 35 OR 25, OR EQUAL BY WARD OR NEXUS.
4. FACTORY-FABRICATED SLIDE-ON CONNECTORS ALSO MAY BE USED, DUCTMATE SPIRAL-MATE, OR EQUAL BY WARD OR NEXUS.
5. FACTORY-FABRICATED SLIDE-ON CONNECTORS ALSO MAY BE USED, DUCTMATE OVAL-MATE, OR EQUAL BY WARD OR NEXUS.
6. OPERATING PRESSURES ARE BASED ON MAXIMUM DESIGN PRESSURES, ALSO REPRESENTED AS EXTERNAL STATIC PRESSURES (ESP).
7. USE MINIMUM SMACNA DUCT PRESSURE CLASSIFICATION OF 1 IN WG. DO NOT USE 1/2 INCH CLASSIFICATION.

B. Intermediate Reinforcement: Match duct material.

C. Elbow Configuration:

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1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE-1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE-3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE-2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 1) Fabricate elbows with single thickness blades with 2-inch inside radius for ducts with dimensions up to 18x18 and double thickness blades for dimensions 18x18 and larger.
 - 2) Turning vanes may be deleted when duct dimensions are less than 12x12.
 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Elbows shall be solid welded gored type constructed in accordance with Fig. 3-6 and Table 3-1 of SMACNA HVAC Duct Construction Standards. Mitered elbows may only be used where indicated on the Drawings. When used, mitered elbows shall always be supplied with single thickness turning vanes.
 - b. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
 - 1) Velocity up to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 2) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - c. Round Elbows:
 - 1) Diameter 8-inches and Smaller: Stamped or pleated.
 - a) Adjustable elbows with lock-form joints are also acceptable.
 - 2) Diameter 10-inches and Larger: Welded gore-type.
 - a) 90-degree elbows shall have minimum 5 gores.
 - b) 45-degree elbows shall have minimum 3 gores.
- D. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch:
 - 1) Velocity up to 1500 fpm: Conical.

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- 2) Velocity greater than 1500 fpm: 45-degree lateral.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Round and Flat Oval Main to Round Branch:
 - 1) Velocity up to 1000 fpm: 90-degree tee.
 - 2) Velocity up to 2000 fpm: Conical.
 - 3) Velocity greater than 2000 fpm: 45-degree lateral.
3. Construct tees, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
4. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
5. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4-inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
6. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections. Straight 90-degree round take-offs are allowed off rectangular ducts for single diffuser taps only.
7. Divided or diverging flow fittings shall be constructed as separate fittings. Tap collars welded into spiral duct sections are not acceptable.
- E. General Cleanliness Requirements: Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines".
 1. Minimum Duct Cleanliness Level: C ("Advanced Level")
 - a. Internal surfaces shall be wiped clean after fabrication prior to sealing for shipment.
 - b. Self-adhesive labels may be affixed to only the outside surfaces of the duct.

2.3. TRAVERSE DUCT CONNECTION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate.
 2. Ward.
 3. Nexus.

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- B. Product Description: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
- C. Duct connectors shall be equal to Ductmate 35 or 25 Systems, slide-on type. The 35 System joint shall be the equivalent of a SMACNA "J" connection. The 25 System joint shall be the equivalent of the SMACNA "F" connection. Duct connectors shall be tested by an independent recognized testing laboratory.
- D. Duct connectors shall consist of roll formed angle frames with integral sealant, corner pieces with nuts and bolts, metal cleats and gasketing. (Metal cleats only, PVC cleats not acceptable, with the exception of breakaway joints at fire damper sleeves.)
- E. Gasketing shall be equal to Ductmate Type 440 synthetic polymer (Butyl) based gasket/sealing tape or approved equal.
- F. Connectors shall be selected for the system duct construction specified. Select in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible and the manufacturers published criteria for positive and negative applications. The manufacturer shall assist in the selection of all duct connectors. Select methods of construction and gages as required to accommodate prefabricated duct connectors.
- G. Angle flange connectors shall be fastened in each corner and 12-inches o/c minimum thereafter unless the MFR requires more stringent fastening. The type/style of fastening must be submitted for approval prior to ductwork fabrication.

2.4. SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

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10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 - a. Type: S.
 - b. Grade: NS.
 - c. Class: 25.
 - d. Use: O.
 2. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5. HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

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- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1. DUCT SCHEDULE

- A. General Building Air Systems: Applies to general building supply, return, exhaust, ventilation and relief air duct. Refer to Part 2, Metal Duct Minimum Construction Standards chart for construction standards of standard supply, transfer, return and exhaust duct. Refer to this Duct Schedule section for special applications.
 - 1. Indoor Duct:
 - a. Concealed or Exposed to View in Mechanical Rooms: Single-wall galvanized sheet steel. Round and oval duct shall have longitudinal or spiral seams.
 - b. Exposed to View in Occupied Spaces: Double-wall galvanized sheet steel. Round and oval duct shall have spiral seams.
 - 2. Outdoor Duct:
 - a. Insulated Systems: Double-wall galvanized steel with painted flat white exterior surfaces.
 - b. Insulated Systems: Single-wall galvanized steel. Refer to Section 230713 for insulation and field-applied jacket requirements.
 - c. Uninsulated Systems: Single-wall galvanized steel.
- B. Air Plenums: Applies to air plenums for general building ventilation and relief air systems.
 - 1. Construction: Plenums shall be constructed with materials matching connected duct construction.
 - 2. Access Doors: Refer to Section 233300 for access door requirements.

3.2. DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts

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and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Duct Dimensions: Dimensions in the construction documents indicate as follows:
 - 1. Rectangular Duct: Nominal inside width and height of the duct.
 - 2. Round Duct: Nominal inside diameter of the duct.
 - 3. Oval Duct: Nominal inside width and depth diameter (of the round sides connecting the flat portions) of the duct.
 - 4. Double-Wall Duct: For double-wall duct, the inside is defined as the inner-duct.
- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Install ducts according to SMACNA's "Duct Cleanliness for New Construction Guidelines".
 - 1. Store duct, fittings and accessories on pallets in a clean and dry location.
 - 2. All sections of duct, fittings and accessories shall be sealed for shipping and storage. They may be sealed at all openings with polyethylene film, shrink-wrapped, bagged or equivalent. Exposed openings shall remain sealed until temporary filtration is in place.
 - 3. Temporary filter media shall be installed on both return and exhaust ducts/inlets if system is operated for conditioning prior to occupancy.
 - 4. Internal surfaces shall be wiped clean as each is installed to prevent construction dust and debris from accumulating.
- E. Install round and flat-oval ducts in maximum practical lengths.
- F. Install ducts with fewest possible joints.
- G. Install factory or shop fabricated fittings for changes in direction, size, and shape and for branch connections.
- H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1-inch plus allowance for insulation thickness.
- K. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- L. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

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- M. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements of the specifications for fire and smoke dampers.
- N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.3. INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.4. HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 10 feet.

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- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- G. Install outdoor duct, supports and building attachments to comply with Section 230548 wind and seismic restraint requirements. Coordinate attachments with building structure and roof.

3.5. CONNECTIONS

- A. Make connections to equipment with flexible connectors.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6. PAINTING

- A. Paint interior of all metal duct that is visible through registers and grilles and that does not have duct liner.
- B. Paint exterior of all galvanized metal duct that is exposed-to-view. Do not paint stainless steel duct unless otherwise directed.
 - 1. Exception: Do not paint duct in mechanical rooms, mezzanines or penthouses.
- C. Painting Duct:
 - 1. Clean duct of dirt, grease and lubricants with a non-hydrocarbon "green" cleaner.
 - 2. Prime duct with 2 coats of water-based white acrylic primer paint designed for use with galvanized steel.
 - 3. Finish duct with 2 coats of latex paint.
 - a. Exterior Duct Surfaces: Color and finish shall be chosen by the owner/ architect.
 - b. Interior Duct Surfaces: Flat black.
- D. Apply paint and primer at the recommended spreading rate and film thickness as recommended by the paint manufacturer.
- E. Apply paint and primer within the environmental conditions recommended by the paint manufacturer but not less than 55F; not more than 90F; and not more than 70% RH.
- F. Mill phosphatized or bonderized "paint grip" steel is not acceptable. Galvannealed sheet metal using a continuous hot-dipping method is an acceptable alternative.

3.7. FIELD QUALITY CONTROL

- A. Engineer to inspect all ductwork at operating pressure prior to insulation for leakage. All leakage shall be repaired.
- B. Perform tests and inspections.

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C. Leakage Pressure Tests:

1. Test 100% of supply, return, exhaust, relief and ventilation duct at pressures equal to their maximum static pressure classifications. Do not over-pressurize systems above their maximum designed operating pressure.
 - a. Low pressure duct (2-inches w.g. or less) listed below shall be tested for leakage unless, in the judgement of the Engineer, it is not required. The Engineer has the option to make this judgement based on a visual inspection of the quality of sealant application. Poor workmanship will result in leakage testing of all duct.
 - 1) Return air duct for return plenum systems under negative pressure and less than 30 ft. total length of duct.
 - 2) Return air duct from the intake of fan coil units and blower coil units under negative pressure and less than 30 ft. total length of duct.
 - 3) Exhaust air duct under negative pressure and less than 30 ft total length of duct.
 - 4) Ventilation air duct under negative pressure and less than 30 ft. total length of duct.
 - 5) Supply air duct from the discharge of terminal units, fan coil units and blower coil units under positive pressure and less than 30 ft. total length of duct.
2. Test duct leakage per 2013 ASHRAE Fundamentals Handbook Chapter 21 and 2016 ASHRAE HVAC Systems and Equipment Handbook Chapter 19 with an average leakage rate for each duct system as specified in Table 3 for the leakage class specified in Part 3 of this section.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Provide 10-day notice for testing.
6. Testing performed prior to the installation of duct accessories, such as dampers and access doors, is not valid. Alterations of the systems due to incomplete or non-conforming work made after testing will void previous test results and require new testing at no additional cost to the owner or engineer. Verify related work is complete before starting.

D. Leakage Light Tests:

1. Test 100% of commercial kitchen hood exhaust air duct. Perform leakage test using light complying with the current edition of the Mechanical Code and the following, whichever is stricter.
 - a. Perform the tests in low ambient light levels.
 - b. Pass a 2500 lumen light source, such as a 150-watt incandescent or 40 watt LED lamp, through the entire length of the duct.
 - c. Inspect 100% of all joints to ensure they are liquid-tight.

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- d. If light is detected at any point, remake and retest joints until all pass.
 - e. Once the duct is completely tested and proved compliant, allow the Owner and Engineer to witness the test.
- E. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- F. Duct system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.8. DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with specification for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

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4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide drainage and cleanup for wash-down procedures.
 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

END OF SECTION

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SECTION 23 33 00 – METAL DUCT ACCESSORIES

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes air duct accessories including relief, volume, control and life-safety dampers; flexible ducts; flange and flexible connectors; turning vanes; duct silencers; duct-mounted access doors; pressure relief doors and duct hardware.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Close-Out Submittals:
- C. Life-Safety Damper Inspection Reports: Document testing and results for all life-safety dampers including installation and operation inspection, engineer's inspections and AHJ's inspections.
 - 1. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.3. 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed but no less than 10 total.

PART 2 - PRODUCTS

2.1. ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

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- C. Provide dampers constructed with materials matching the duct system.
 - 1. Exception: Use Type 304 stainless steel in galvanized duct subject to moist airstreams such as humidifiers, locker room exhaust, pool rooms, steam autoclaves, etc.

2.2. MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.3. STATIC PRESSURE GAGES

- A. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2-percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4-inch diameter tubing. Provide 3-way vent valves.

2.4. GRAVITY BALANCED BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity-balanced dampers for backdraft or pressure relief. Dampers shall have adjustable tension return spring; steel ball bearings; counter-weights and spring-assist kits for vertical flow applications; and bird screens. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2-inches w.g. maximum system pressure.
 - 1. Frame: Hat-shaped with welded corners or mechanically attached and mounting flange, constructed of one of the following to match the duct system material type for each: 12-gauge thick, galvanized sheet steel; 0.063-inch thick extruded aluminum; or 0.05-inch thick stainless steel.
 - 2. Blades: Parallel-action, multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch thick, roll-formed aluminum with mechanically-locked neoprene blade seals and 0.20-inch diameter stainless steel blade axles.

2.5. BAROMETRIC RELIEF DAMPERS

- A. Description: Barometric relief dampers for pressure relief. Dampers shall have return spring or adjustable tension counter-weight; stainless steel bearings; and bird screens. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2-inches w.g. maximum system pressure.

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1. Frame: Hat-shaped with welded corners or mechanically attached and mounting flange, constructed of one of the following to match the duct system material type for each: 16-gauge thick, galvanized sheet steel; 0.093-inch thick extruded aluminum; or 18-gauge stainless steel.
2. Blades: Parallel-action, multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch thick, roll-formed aluminum with mechanically-locked neoprene blade seals and 0.20-inch diameter stainless steel blade axles.

2.6. MANUAL VOLUME DAMPERS

- A. Standard Rectangular, Steel, Manual Volume Dampers: Standard leakage rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2.5-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MD35.
 1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.
 2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 8-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.
- B. Standard Round, Steel, Manual Volume Dampers: Standard leakage rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 1500 fpm maximum air velocity and 2-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MDRS25
 1. Frame: Constructed of 20-gauge thick galvanized sheet steel, flangeless for in duct installations.
 2. Blades: Single-blade, center-pivot, 20-gauge thick galvanized sheet steel, 0.375-inch diameter galvanized steel blade axle and 90-deg quadrant handle. Provide 2-inch handle extension wherever duct system will be insulated.
- C. Damper Hardware: Zinc-plated, die-cast core with hand quadrant dial and handle made of 3/32-inch thick zinc-plated steel, and hexagon locking nut. Include elevated platform for insulated duct mounting.
 1. Handle operation shall be painted orange.

2.7. CONTROL DAMPERS

- A. Standard Low-Pressure Rectangular, Steel, Control Dampers: Standard leakage rated damper suitable for horizontal or vertical volume control applications with synthetic or stainless steel bearings. Dampers shall be rated for 2,000 fpm maximum air velocity, 2.5-inches w.g. maximum system pressure and maximum leakage of 10 cfm/sqft. at 1.0-inches pressure. Provide dampers equivalent to Ruskin CD35.
 1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.

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2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 6-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.
 3. Applications:
 - a. Operating Pressure: Up to 2.0-inches w.g.
 - b. Operating velocity: Up to 1,500 fpm.
 - c. Throttling: Opposed-blade type.
 - d. Two-Position (Open/Closed): Parallel type.
- B. Standard Medium-Pressure Rectangular, Steel, Control Dampers: AMCA Class 2 leakage damper suitable for horizontal or vertical volume control applications with oil-impregnated stainless steel bearings. Dampers shall be rated for 3,000 fpm maximum air velocity and 5.0-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin CD36.
1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.
 2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 6-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.
 3. Applications:
 - a. Operating Pressure: Up to 4.0-inches w.g.
 - b. Operating velocity: Up to 2,500 fpm.
 - c. Throttling: Opposed-blade type.
 - d. Two-Position (Open/Closed): Parallel type.
- C. Standard Low-Pressure Round, Steel, Control Dampers: Standard rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 1,500 fpm maximum air velocity and 2.0-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MDRS25.
1. Frame: Constructed of 20-gauge thick galvanized sheet steel, either with flanges on both sides or internal duct mounting.
 2. Blades: Single-blade action, 20 gauge-thick steel, center-pivot, closed cell rubber edge seals and galvanized steel blade axles.
 3. Applications:
 - a. Operating Pressure: Up to 1.0-inches w.g.
 - b. Operating velocity: Up to 1,000 fpm.
- D. Medium-Pressure Round and Oval, Steel, Control Dampers: AMCA Class 2 damper suitable for horizontal or vertical volume control applications with stainless steel bearings. Unless otherwise indicated, dampers shall be rated for 4,000 fpm maximum air velocity and 10.0-

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inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin CDR25 (round) / CDO25 (oval).

1. Frame: Constructed of 14-gauge thick galvanized sheet steel, either with flanges on both sides or internal duct mounting.
2. Blades: Single-blade action, 12 gauge-thick steel, center-pivot, closed cell rubber edge seals and galvanized steel blade axles.
3. Applications:
 - a. Operating Pressure: Up to 8.0-inches w.g.
 - b. Operating velocity: Up to 3,200 fpm.

2.8. LIFE-SAFETY DAMPERS

A. General Requirements:

1. Temperature Activation Rating: Fusible links and/or heat sensors shall be rated for 165 deg F in general air duct systems (up to 120 deg F) and rated for 212 deg F in high temperature duct systems (greater than 120 deg F) such as smoke control.
2. Frame Style: Rectangular life-safety dampers shall have Type B curtain-style blades outside the air stream except for tight locations where otherwise noted or pre-approved by the Engineer.
3. Minimum Dimensions: Damper height or width dimension shall be minimum 8-inches to allow a minimum 12-inch by 6-inch access door and adequate space to test and maintain damper, regardless of duct dimensions. Refer to 'Duct-Mounted Access Doors' in this section for more information about sizing.
4. Sidewall Grilles: Dampers installed behind sidewall grilles shall be fully serviceable through the grille.

B. Fire Dampers: 1-1/2 and 3-hour UL 555 and FM rated and labeled dynamic fire dampers suitable for horizontal or vertical applications with 4-inch w.g. closing rating static pressure class and minimum 2000 fpm rated velocity.

1. Frame: Factory-fabricated with roll-formed 20-gauge thick galvanized steel and mitered and interlocking corners.
2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application.
3. Blades: Roll-formed, interlocking, 20-gauge thick, galvanized sheet steel. In place of interlocking blades, use full-length, 20-gauge thick, galvanized-steel blade connectors.

C. Smoke Dampers: UL 555S and FM rated and labeled, Class 1 leakage rated smoke dampers with stainless steel permanently lubricated bearings suitable for wall or floor applications and rated for pressure up to 8-inches w.g. and velocity up to 4000 fpm. Dampers shall have two-position, fail closed, 115 V / 1 phase / 60 Hz actuator motors and disconnect.

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1. Frame: Hat-shaped, 16-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.
 2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application and length to suit wall or floor application.
 3. Blades: Airfoil, horizontal, maximum 6-inch wide, 14-gauge thick, galvanized sheet steel with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.
 4. Linkage: Concealed in frame.
 5. Damper Test and Reset Control Panel: Damper test switch with remote damper position indicator (open or closed) and manual reset button to re-open damper after a fire or test.
 6. Duct-Mounted Smoke Detector: Integral, factory wired for single-point connection. Detectors are required to be installed within 5 feet of each smoke damper in a ducted system without air inlets or outlets between the damper and detector.
 - a. Exception: When the building has “total coverage” by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.
 7. Smoke Detector: Ceiling or wall-mounted spot-type smoke detector wired for single-point connection. Detectors are required to be installed within 5 feet horizontally of the damper when the damper is located above smoke barrier doors in a smoke barrier door opening or when the damper is located in a non-ducted opening in a smoke barrier.
 - a. Exception: When the building has “total coverage” by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.
- D. Combination Fire and Smoke Dampers: 1-1/2 and 3 hour UL 555, UL 555S and FM rated and labeled, Class 1 leakage rated combination fire and smoke dampers with stainless steel permanently lubricated bearings suitable for horizontal or vertical applications and rated for pressure up to 8-inches w.g. and velocity up to 4,000 fpm. Dampers shall have two-position, fail closed, 115 V / 1 phase / 60 Hz actuator motors and disconnect. Electric resettable link with heat sensor shall be rated for 165 deg F activation, except for high temperature applications.
1. Frame: Hat-shaped, 16-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.
 2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application and length to suit wall or floor application.
 3. Blades: Airfoil, horizontal, maximum 6-inch wide, 14-gauge thick, galvanized sheet steel with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.
 4. Linkage: Concealed in frame.
 5. Duct-Mounted Smoke Detector: Integral, factory wired for single-point connection. Detectors are required to be installed within 5 feet of each smoke damper in a ducted system without air inlets or outlets between the damper and detector.

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- a. Exception: When the building has “total coverage” by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.
- 6. Smoke Detector: Ceiling or wall-mounted spot-type smoke detector wired for single-point connection. Detectors are required to be installed within 5 feet horizontally of the damper when the damper is located above smoke barrier doors in a smoke barrier door opening or when the damper is located in a non-ducted opening in a smoke barrier.
 - a. Exception: When the building has “total coverage” by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.
- 7. Actuator Location: Actuator shall be located outside the airstream unless otherwise indicated.
 - a. Exception: Dampers at wall grilles shall have actuators either inside the airstream or in a separated compartment and accessible through the opened grille face. Dampers shall be rated for pressure up to 4-inches w.g. and velocity up to 2000 fpm.
- E. Fan Smoke Isolation Dampers: UL 555S and FM rated and labeled, Class 1 leakage rated smoke dampers with stainless steel bearings suitable for horizontal or vertical mounted fan isolation applications and UL listed and labeled for pressure up to 6-inches w.g. and velocity up to 2000 fpm. Dampers shall have modulating, fail closed, 115 V / 1 phase / 60 Hz actuator motors.
 - 1. Frame: 12-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.
 - 2. Blades: Airfoil, horizontal, maximum 8-inch wide, 0.08 thick, extruded aluminum with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.
 - 3. Position Switches: Two-position switches linked to damper blade to remotely indicate damper blade position.
- F. Smoke and Combination Smoke and Fire Damper Test Panels: Factory-fabricated accessory provided with smoke and combination smoke and fire dampers with test button, damper open indicator light and damper closed indicator light. Provide panels rated for either 120V or 24V to match the damper voltage. Unit shall be designed for flush-mounting and surface-mounting as required. Ruskin MCP4/MCP44 or Engineer approved equal.

2.9. TURNING VANES

- A. Turning Vanes for Metal Ducts: Factory-fabricated, double-wall, curved airfoil-shaped blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting. Comply with details in SMACNA “HVAC Duct Construction Standards – Metal and Flexible”

2.10. DUCT-MOUNTED ACCESS DOORS

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- A. General: Factory-fabricated access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Doors: Factory-fabricated access doors shall be air-tight suitable for associated duct pressure and leakage classification. All doors shall be rigid and close fitting and include sealing gaskets and quick locking devices. Door construction materials shall match metal duct type, galvanized steel, stainless steel or aluminum.
 - a. Access doors must be installed prior to duct pressure and leakage testing. If the Engineer determines the access doors cannot meet the requirements of the testing, they shall be replaced with a higher quality door at the contractor's expense.
 - b. Access panels with sheet metal screw fasteners are not acceptable.
 2. Frames: Galvanized sheet steel, with bend-over tabs and foam or neoprene gaskets. Security chain to restrain door to frame.
 3. Hinges and Latches:
 - a. Doors up to 12-inches Square: Secure with sash locks.
 - b. Doors up to 18-inches Square: Provide two hinges and two sash locks.
 - c. Doors up to 24 x 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Larger door sizes: Provide an additional hinge.
- B. Standard Duct-Mounted Access Doors: Doors in uninsulated duct shall be single-wall. Doors in insulated duct shall be double-wall with 1-inch of mineral fiber or foam insulation fill.
1. Rectangular Duct-Mounted Access Doors: Rectangular and square access doors for rectangular and flat oval duct.
 - a. Life-Safety Damper Access: Doors installed to provide access to life-safety dampers shall be minimum 12-inches square.
 - 1) Duct without a 14-inch or larger dimension shall transition to a size with at least one 14-inch dimension to allow for 12-inch square access door.
 - a) Exemptions: Sidewall grilles and ceiling radiation dampers.
 - 2) Ducts with a dimension from 14 to 24-inches shall have square access doors 2-inches less than largest duct dimension.
 - 3) Ducts with a dimension of 26-inches or larger shall have 24-inch by 24-inch duct access doors.
 - b. Equipment and Sensor Access: 12 x 6-inch rectangular access doors shall be used in 8-inch largest dimension ducts; 12 x 8-inch rectangular doors in up to 12-inch ducts; 12-inch square doors in up to 18-inch ducts; 18-inch square doors in up to 24-inch ducts; and 24-inch square doors in 26-inch and larger ducts.

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2. Oval and Round Duct-Mounted Access Doors: Oval access doors for round and oval ducts. Equivalent to Ruskin ADR Series.
 - a. Door Sizes: 8-inch by 4-inch access doors shall be used in 4 and 6-inch diameter round ducts; 10-inch by 6-inch doors in 6 to 12-inch ducts; and 16-inch by 12-inch doors in 14-inch and larger ducts.
 - 1) Life-Safety Damper Access: Transition round and oval duct to rectangular duct matching life-safety damper dimensions. Install access doors in accordance with Rectangular Duct-Mounted Access Doors paragraph above.
- C. Plenum-Mounted Access Doors: Open outward for positive-pressure ducts and inward for negative-pressure ducts. Full height plenums shall have 72-inch tall x 30-inch wide door with vision panel and mounted between 4 and 12-inches above the floor unless otherwise indicated.

2.11. DUCT TEST HOLES

- A. Permanent Test Holes: Factory-fabricated, air-tight, flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.12. FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene with a minimum weight of 26 oz/sqyd; tensile strength of 480 lbf/inch in the wrap and 360 lbf/inch in the filling; and a service temperature range of (-) 40 deg F to 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone with a minimum weight of 24 oz/sqyd; tensile strength of 530 lbf/inch in the wrap and 440 lbf/inch in the filling; and a service temperature range of (-) 50 deg F to 250 deg F.
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct. They shall be factory-fabricated for HVAC applications up to 10-inches w.g. of pressure.
- G. Grounding Straps: Flexible braided copper grounding strips, flat or round, providing an equivalent ampacity of a #6 AWG conductor.

2.13. FLEXIBLE DUCTS

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- A. General: Flexible duct shall comply with UL 181, Class 1 and have flame spread rating of less than 25 and smoke developed rating of less than 50.
- B. Non-Insulated, Flexible Duct: Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire. Duct shall have 10-inch w.g. positive and 1-inch w.g. negative pressure ratings; maximum air velocity of 4000 fpm; and temperature rating of (-) 20 deg F to 210 deg F.
- C. Insulated, Flexible Duct: Double-ply polyester film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film. Duct shall have 10-inch w.g. positive and 1-inch w.g. negative pressure ratings; maximum air velocity of 4000 fpm; and temperature rating of (-) 10 deg F to 160 deg F. Insulation value shall meet or exceed R-value of connected duct insulation.
- D. Flexible Duct Connectors: Stainless steel bands with cadmium-plated hex screws to tighten band with a worm gear action sized to suit duct size.

2.14. DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1. INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.
 - 1. Provide instruments with scale ranges selected according to service with largest appropriate scale. Filter gauges shall be 0 to 2-inch scale.
- D. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- E. Whether or not indicated on plans, install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and

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- terminate liner with nosing at hat channel. Damper construction materials shall match duct system materials.
1. Volume damper handle positions shall match volume damper positions. If the damper is closed, the handle should be perpendicular to the direction of airflow. If the damper is open, the handle should be parallel to the direction of airflow.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install life-safety dampers according to UL listing and coordinate their location and adjacent installations to ensure they are fully accessible for maintenance and testing.
- I. Connect ducts to duct silencers rigidly unless otherwise indicated.
- J. Access Doors: Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. Upstream or downstream from duct silencers.
 8. Control devices requiring inspection or cleaning.
 9. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Label access doors according to Section 230553 to indicate the purpose of access door.
- M. Install pressure relief doors in manufacturer recommend orientation, generally vertical, and in locations within mechanical space and opening away from maintenance walkways. Paint doors safety orange.
- N. Install temporary duct test holes as required for testing and balancing purposes. Cut or drill ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- O. Install flexible connectors to connect ducts to equipment. Install flexible grounding strip(s) from equipment to duct.
- P. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

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- Q. Connect diffusers to ducts with up to 6-foot maximum lengths of flexible duct clamped or strapped in place, unless otherwise indicated.
- R. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws and tape.
- S. Install duct test holes where required for testing and balancing purposes.
- T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2. CONTROL DAMPERS

- A. Control Dampers for Air Handling Equipment:
 - 1. Outside Air (OA) Dampers: Provide damper types noted in the air handling unit sections and on the drawings. Dampers sized for 2,000 FPM face velocity at full flow and 100 FPM at 5-percent flow.
 - a. Opposed-blade type.
 - b. Parallel-blade type. Orient blades to direct air flow away from coils and toward outside air flow to promote mixing.
 - 2. Relief Air (RelA) / Exhaust Air (EA) Dampers:
 - a. Fan: Opposed-blade type sized for 2,000 FPM face velocity at full flow.
 - b. Barometric: Parallel-blade type sized for 1,000 FPM face velocity at full flow.
 - 3. Return Air (RA) Dampers: Parallel-blade type sized for 1,500 FPM face velocity at full flow. Orient blades to direct air flow away from coils and toward outside air flow to promote mixing.
 - 4. AHU RA Inlet / SA Outlet: Smoke isolation dampers, full duct or opening size.

3.3. FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

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6. Life-Safety Damper Testing: Dampers shall be 100% tested and verified to be open and operational through their full range of movement. Damper testing shall be performed by contractor with minimum 5-years of experience in testing life-safety dampers. Within 2 weeks of written certification that all dampers are correct, Engineer shall inspect dampers prior to AHJ inspection.

- a. Test Procedures:

- 1) Fire dampers with fusible links shall be tested by removing the fusible link. Observe that damper closes completely.
- 2) Fire dampers with firestats shall be tested with a heat gun. Observe that damper closes completely.
- 3) Smoke dampers shall be tested by smoking the duct smoke detector with canned smoke. Observe that damper closes completely. In cases where smoke dampers are controlled through the Fire Alarm Control Panel and do not necessarily close on individual duct smoke detectors, use the FACP to close the dampers.
- 4) If any dampers do not close completely, correct installation and retest.
- 5) After verification of damper closing, verify that damper reopens to normal position without blockage of air flow. Reset fusible links and firestats. Close access door.

- b. Test Report:

- 1) Provide written report to Engineer and signed by the responsible Contractor representatives.
- 2) Report shall list each fire and smoke damper with test results for each damper including time, date, and name of test technician for each test.
- 3) Report shall include a table showing each damper with a unique identification for each damper. Report shall include a notation of whether damper is in supply, return, exhaust or other type of duct.
- 4) Report shall include drawings showing the location of each damper on the floor plans.

3.4. DEMONSTRATION

- A. Demonstrate re-setting of fire dampers for Owner and Engineer.
- B. Provide Owner training in compliance with Section 230200.

END OF SECTION

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SECTION 23 34 00 – HVAC FANS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes centrifugal roof ventilators.

1.2. PERFORMANCE REQUIREMENTS

- A. Operating Limits: Classify according to AMCA 99.

1.3. SUBMITTALS

- A. Product Submittals: For each type of product indicated include rated capacities, operating characteristics, and furnished specialties and accessories. The product data shall also include the following: certified fan performance curves with system operating conditions indicated; certified fan sound-power ratings; motor ratings and electrical characteristics, plus motor and electrical accessories; material thickness and finishes; dampers, including housings, linkages, and operators; roof curbs; and fan speed controllers.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.4. QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

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. Belts: Two set(s) for each belt-driven unit.

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PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Greenheck Fan Corp.
 - 2. Loren Cook Company
 - 3. Twin City Fan and Blower
 - 4. Air handling unit or Packaged equipment manufacturer
- B. Description: Factory fabricated, assembled, tested, and finished, belt-driven or direct-driven (as scheduled) fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly and support structure with factory installed and wired service disconnect switch. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
- C. AMCA Compliance: Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal. Classify operating limits according to AMCA 99.
 - 1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
 - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."
- D. Shafts: Fan shafts shall be statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning. Shafts shall be turned, ground, and polished hot-rolled steel with keyway and finished with an anti-corrosive coating. They shall be designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow-block type bearings rated for L10 at 100,000 hours.
 - 1. Extend grease fitting to accessible location outside of unit.
- F. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 - 1. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

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3. Belts: Oil resistant, non-sparking, and non-static V-belts; in matched sets for multiple-belt drives.
 4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 5. Motor Mount: Adjustable for belt tensioning.
- G. Direct Drives: Factory-mounted with 1.2 service factor based on fan motor.
- H. Motors: Comply with requirements of Section 230513.
- I. Speed Controller: Where indicated, provide solid-state, factory-mounted, manual speed controller on 115V or 230V single-phase, direct-drive fans for air flow balancing.
- J. Variable Frequency Controllers: Refer to Section 230514.
1. Variable frequency drives shall not be installed outdoors without supplemental cooling.
- K. Motor Starters and Disconnects: Refer to Section 230511.
1. Disconnect Switch: Factory wired and mounted non-fusible type with thermal-overload protection mounted to the fan housing, unless otherwise indicated. Wiring shall be enclosed in aluminum conduit.
- L. Dampers: Motor-operated, parallel blade aluminum dampers mounted in the curb base shall open when the fan starts and close when it stops. Refer to Section 233300.
1. Where indicated, provide counter-balanced backdraft dampers in lieu of motor-operated type.
- M. Roof Curbs: Factory-fabricated welded-seam self-flashing roof curb to match fan and roof-slope, constructed of galvanized sheet metal with 1 1/2-inch pressure-treated wood nailer, water-tight gasket, 1 1/2-inches of rigid fiberglass insulation, damper tray, and finished with primer and powder baked white enamel.
1. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match exhaust fan, used to anchor unit to the curb, and designed for loads at project site. Comply with requirements in Section 230548.
 2. Curb Height: 16-inches with a minimum of 12-inches above the finished roof surface.

2.2. CENTRIFUGAL ROOFTOP FANS

- A. General Description: Rooftop fan with removable spun-aluminum dome top and outlet baffle; square one-piece aluminum base with venture inlet cone; fan wheel with aluminum hub and wheel with backward-inclined blades; and belt or direct-drive as scheduled. Outlet shall have removable 1/2-inch aluminum mesh birdscreen. The drive shall be equipped with an automatic belt tensioner.
- B. Rooftop Dome-Type Downblast Centrifugal Fans:
1. Greenheck G/GB Series, Loren Cook ACE Series, or Twin City BCRD/DCRD Series.

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2. Application: General building exhaust systems.

PART 3 - EXECUTION

3.1. GENERAL INSTALLATION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548.
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- D. Install units with clearances for service and maintenance.
- E. Label units according to requirements specified in Section 230553.

3.2. CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

3.3. FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.

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8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Prepare test and inspection reports.

3.4. ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow. Coordinate with the TAB Contractor.
- E. Lubricate bearings.

END OF SECTION

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SECTION 23 41 00 – PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes standard efficiency pleated panel, filter frames; and filter gages.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.3. QUALITY ASSURANCE

- A. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- B. Comply with NFPA 90A and NFPA 90B.
- C. Filters shall be compatible with Ultraviolet Germicidal Irradiation (UVGI) lamps where UVGI lamps are specified for use in air handling units. Do not use synthetic filters in instances where UVGI lamps are specified.

1.4. 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. Provide two (2) complete set(s) of filters for each filter bank.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airguard
 - 2. American Air Filter (AAF) / Flanders
 - 3. Camfil (Farr)

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- B. Filter Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks. Frames shall provide an airtight fit with the enclosing ductwork. All joints between filter segments and enclosing ductwork shall have gaskets or seals to provide a positive seal against air leakage.

2.2. PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, UL 900 Class 2, disposable air filters with holding frames. Media shall be interlaced glass or synthetic fibers coated with non-flammable adhesive. Filter-media frame shall be cardboard sealed or bonded to the media.
 - 1. 2-inch, MERV-8 with maximum initial resistance of 0.25-inches w.g. at 500 fpm.
 - 2. 4-inch, MERV-8 with maximum initial resistance of 0.37-inches w.g. at 500 fpm.

2.3. FILTER GAGES

- A. Description: Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
- B. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0 to 2.0-inches w.g. and accurate within 3 percent of the full-scale range.
- C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1. INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- F. Coordinate filter installations with duct and air-handling-unit installations.

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3.2. CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

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SECTION 23 73 19 – SEMI CUSTOM INDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes semi-custom indoor central-station air handling units.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product indicated.
 - 1. Product Data: For each air-handling unit indicated, provide unit dimensions and weight; cabinet material, metal thickness, finishes, insulation, and accessories; certified fan-performance curves with system operating conditions indicated; certified fan-sound power ratings; fan construction and accessories; motor ratings, electrical characteristics, and motor accessories; certified coil-performance ratings with system operating conditions indicated; dampers including housings, linkages, and operators; and filters with performance characteristics.
 - 2. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved: mechanical-room layout and relationships between components and adjacent structural and mechanical elements; support location, type, and weight; and field measurements.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals. Information shall include descriptive literature, model and serial numbers of all components, performance data, and operation and maintenance instructions.

1.3. QUALITY ASSURANCE

- A. Applicable components of the air handling units shall comply with:
 - 1. Fan Sound-Power Level Ratings: Comply with AMCA 300 and 301. Fans shall bear AMCA-certified sound ratings seal.
 - 2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210.
 - 3. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.
 - 4. NFPA 70 (National Electric Code) and 90A
 - 5. AMCA 204, 205, 211 and 311

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6. AHRI 260, 261, 430 and 1060
 7. ASHRAE 62.1, Section 5 and 7
 8. ASHRAE/IESNA 90.1, Section 6
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Flame-spread index of 25 or less and smoke-developed index of 50 or less.
- C. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- D. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- E. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.4. COORDINATION

- A. Coordinate sizes, weights (operational and shipping) and locations of supports and opening with the actual equipment provided, including:
1. Concrete bases
 2. Structural steel support members

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. Filters: Two set(s) for each air-handling unit.
 2. Fuses: One-set of main fuses in unit-mounted cabinet.
 3. EC Fan: Provide spare fan for units with combination motor / fan selection.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide product by one of the following for custom and semi-custom built air handling units with standard quality casings:

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1. Nortek Air Solutions (Temtrol LC)
2. Daikin
3. Trane (Custom Performance Climate Changer CSAA and PSCA series)
4. VTS

2.2. UNIT CASINGS

- A. Standard Quality Casing Fabrication: Factory-fabricated and constructed self-supporting wall, roof and floor double-wall casing panels with 2-inch (R-16) closed-cell injected-foam insulation within formed channel framing or greater. The casing construction shall provide thermal breaks. All joints shall be air-tight and water-resistant sealed.
1. Casing Performance:
 - a. Leakage: Casing shall meet AHRI 1350 Casing Air Leakage Rate CL3 with less than 10 cfm leakage per 100 sqft. at 6.0-inches w.g. positive or negative internal pressure.
 - b. Deflection: Casing shall meet AHRI 1350 Casing Deflection Rate CD3 with less than 0.0042-inches (1/240) deflection per inch of span at 6.0-inches positive or negative internal pressure. Floor deflection shall not exceed 0.0625-inches at 6-inches internal pressure and 300-pound per sqft. live load.
 2. Casing Materials:
 - a. Exterior: G90 galvanized-steel, smooth, 20-gauge (0.036-inch thick) minimum.
 - b. Interior: G90 galvanized-steel, smooth, 20-gauge (0.036-inch thick) minimum with galvanized-steel structure,
 - 1) Exceptions:
 - a) Cooling coils sections will be Type 304 stainless steel, smooth, 20-gauge (0.038-inch thick) minimum or aluminum 16-gauge (0.050-inch-thick) minimum with stainless steel screws.
 3. Casing Finish: None
 4. Casing Section Gaskets: Neoprene gasket around entire perimeter of casing section joints.
- B. Floor: Each section shall have a 2-inch tall lip at the perimeter to form a water-tight pan. Walking surfaces of floor panels shall have a solid 3/16-inch thick checker-plate aluminum solid lining with water-tight welded seams and reinforcements to support 300-pound per sqft. live load
- C. Monorail Beams: Each fan section shall include a structural I-beam monorail capable of lifting the fan motor(s) through the fan section access door on the primary service side of the unit.
- D. Access Doors and Panels: Factory-fabricated double wall, to match casing and insulation materials, finish and performance and suitable for unit pressure and leakage classification. Doors shall open against positive pressure and be large enough to remove associated

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- components such as motors, filters, etc. but no smaller than 12-inches wide and 48-inches tall. Additional access panels shall be provided to aid in removal of components such as fans, coils, etc.
1. Door Hinges, Latches and Handles: Minimum of two ball-bearing or piano hinges, two wedge-lever latches and quarter-turn handles.
 2. Door Gaskets: Neoprene gasket around entire perimeter of door frames.
- E. Condensate Drain Pans: Drain pans shall be factory-fabricated, minimum 16-gauge, Type 304 or 316 stainless steel, water-tight sealed, and minimum 2-inch deep. Pans shall be sloped in two directions to collect condensate from cooling coils (including coil piping connections, coil headers and return bends). They shall direct water toward drain connection. Drain connection shall be on the bottom side and at the lowest point of the pan.
1. Main Drain Pans: Pans shall be insulated and extend 6-inches upstream and 24-inches downstream of coil face.
 2. Intermediate Drain Pans: Units with stacked coils shall have intermediate drain pans to collect condensate from upper coils. Intermediate pans shall extend 3-inches upstream and minimum 4-inches downstream of coil face. They shall have 1-inch minimum diameter stainless steel downspout to guide condensate to the main drain pan. Downspouts shall be non-cascading.
 3. Locate drain connection above the base rail of the air handling unit. Drain pan, cooling coil, and section construction must be adjusted to accommodate. This requirement is to ensure adequate p-trap height is available to install above finished floor. Manufacturer to provide estimated static pressure in condensate drain section for worst case p-trap conditions to ensure that drain outlet is higher than combination of discharge height plus concrete pad to consider base rail discharge.
- F. Test Ports: Factory-fabricated test ports shall be provided at each component section for measurement and testing devices. Ports shall be 1-inch diameter with threaded cap. Ports shall be installed prior to pressure and leakage testing. Field drilled ports are not acceptable.
- G. Power and Control Conduit: Conduits from internal components to exterior surface junction boxes shall be factory-installed. The number, minimum sizes and locations of the conduits and junction boxes shall be coordinated with the installing contractor prior to fabrication. All wiring shall be installed in rigid and/or flexible conduit. Flexible liquid-tight conduit shall be used for connections to equipment subject to vibration. Flexible conduit lengths shall be limited to 48-inches. EMT conduit shall not be used inside the unit.
- H. Base Rails: Structural steel channel rails continuous at the unit's perimeter and at intermediate locations needed to support internal components suitable for mounting on structural steel platform or concrete pad. Base rails shall be galvanized with epoxy-based paint finish. Minimum 4" height or as scheduled. See condensate drain discharge location.
- I. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- J. Modular Provisions: Units shall include modular design to fit through a 6 foot mechanical room door with provisions for connecting sections.

2.3. FAN, DRIVE AND MOTOR SECTION

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- A. Fans: Comply with requirements of Section 233400.
- B. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower. Shafts shall be designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
- C. Fan Housings:
 - 1. Plenum Fan Housings: Direct-drive centrifugal type, steel frame and panel, fabricated without fan scroll and volute housing.
- D. Fan Wheels:
 - 1. Centrifugal Plenum Fan Wheels: Airfoil wheels shall be single-width single-inlet (SWSI) construction with heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Fan Arrays: Direct-drive modular-plenum fans in a parallel array, using number of fans indicated on the drawings but not less than 2, arranged to provide equal air flow across the unit's cross-section. The fans in each array shall be identical.
 - 1. Performance: The fans operating in parallel shall meet the performance requirements scheduled. The fans shall be selected to have non-overloading design with self-limiting horsepower characteristics in the normal operation area.
 - 2. Fan Sections: Array support structure materials shall match interior casing material and have 6-inch minimum depth. Monorail or trolley system shall be provided to assist the removal of fan wheels and motors.
 - 3. Backdraft Dampers: Each fan shall have a factory-mounted motor-operated low-leakage backdraft damper that complies with the requirements of Section 233300 unless prohibitive by mounting position.
 - a. Pressure losses across the dampers shall be included in the fan performance data and not considered to be included in the unit's scheduled pressure drop.
 - 4. Variable Speed Drives: Comply with the requirements of Section 230514. Drives manufactured by the air handling unit manufacturer are also acceptable in addition to the manufacturers listed in Section 230514.
 - a. Each fan motor shall be equipped with a dedicated variable speed drive without bypass, unless otherwise noted.
 - b. All drives in an array shall be mounted in a NEMA-1 enclosure with power and control wiring, disconnect switch, and a single-point electrical connection. Individual drives shall have circuit breaker disconnects for individual maintenance.
 - c. Over-Speeding: Air Handling Units with Setback Schedules: Variable frequency drives shall not operate over 90 Hz and motors shall not operate over 3,000 RPM for direct-drive fans used in air handling units at normal operating conditions.

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5. Air Flow Measuring Stations: Differential pressure type piezometer ring mounted on the throat of the inlet cone. Accuracy shall be plus or minus 5 percent, including transducer and conversion error, at 100 to 5,000 fpm.
- F. Fan Shaft Bearings:
 1. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings, L10 rated for 200,000 hours with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.
 2. Permanently Sealed Ceramic Bearings
- G. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
- H. Motors: Comply with requirements of Section 230513.
- I. Variable Frequency Controllers: Refer to Section 230514.
 1. Where indicated to be unit-mounted, mount variable frequency drives on exterior of indoor units per manufacture's recommendations and within dedicated pre-manufactured casing compartment of outdoor units. Variable frequency drives shall not be installed outdoors without supplemental cooling.
- J. Motor Starters and Disconnects: Refer to Section 230511.
 1. Where indicated to be unit-mounted, mount motor starters and disconnect switches on exterior of unit per manufacture's recommendations.

2.4. COIL SECTION

- A. Heating and Cooling Coils: Provide coil types in positions indicated. Comply with requirements of Section 238216. Coils shall comply with ARI 410.
 1. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 2. Coils shall not act as structural component of unit.
 3. Individual cooling coils shall be no more than 36-inches tall. When multiple cooling coils are used in height, provide intermediate condensate drain pans.
 4. Coil sections shall have stainless steel casing liner, coil supports, and accessories.

2.5. MAINTENANCE ACCESS SECTION

- A. Maintenance Access Sections: Provide access sections as indicated in the documents; but not less than 18-inch long section between coils unless otherwise noted.

2.6. ULTRAVIOLET GERMICIDAL IRRADIATION LAMPS

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- A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
1. Lumalier
 2. Sterile-Air
 3. UV Resources
- B. Ultraviolet Germicidal Irradiation (UVGI): Ultraviolet radiation shielded (UV-C) lamps that are UL listed for disinfection in HVAC applications. The UVGI system shall be located for maximum effectiveness and to constantly irradiate the surfaces of the cooling coil and drain pan with a 90% efficiency. Light fixture shall be constructed of stainless steel and suitable for operation in saturated air.
1. Automatic Disconnect: UVGI system shall automatically switch off when the unit access door is opened.
 2. Interlocked Disconnect: UVGI system shall automatically switch on when the unit supply fan is operating and off when it is not.
 3. Status Indication: Provide contacts for indication of status.
 4. Manual Disconnect: UVGI system shall have a unit-mounted manual disconnect switch to turn lights off for testing and maintenance while air handler is in operation. Label switch in compliance with Section 230553.

UVGI DISCONNECT SWITCH

DANGER: TURN UVGI LAMPS OFF
BEFORE ENTERING AHU.

INTERRUPTOR DE DESCONEXION DE LAMPARAS
DE IRRADIACION GERMICIDA ULTRAVIOLETA (UVGI)
PELIGRO: APAGUE LAS LAMPARAS (UVGI)
ANTES DE ENTRAR UTA (AHU).

5. Access Door View Panel: View panel glass in access section with UVGI system shall be ultraviolet light filtering to allow inspection from outside the unit while in operation.
6. UVGI Lamps: UV-C radiation lamps that emit minimum 85% of 253.7 nm wave length; do not generate ozone; and are rated for minimum lamp life of 9000 hours.
 - a. Lamps shall be hermetically sealed within a thin layer of UV-C transmissible Teflon® to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained. "Encapsulated lamps"
7. Warning Sign: Post warning signs on access doors that are exposed to UV light as follows: "Caution: Ultraviolet energy. Protect eyes and skin. Do not switch off safety button or activate lamps with door open."
 - a. Apply warning signs on the access door used to access UV-C lamps and the next door upstream and downstream.

WARNING: ULTRAVIOLET LIGHT HAZARD.

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DIRECT EXPOSURE TO UV-C LIGHT PRODUCED BY UVGI LAMPS MAY
RESULT IN EYE AND SKIN DAMAGE.
NEVER LOOK AT LAMPS WHILE THEY ARE LIT.
DO NOT DISABLE SAFETY DEVICES.
DISCONNECT UVGI POWER BEFORE SERVICING.

PELIGRO: PELIGRO LUZ ULTRAVIOLETA.
EXPOSICION DIRECTA A RADIACION UV-C PRODUCIDA POR LAS
LAMPARAS UVGI PUEDE RESULTAR EN DAÑOS A LOS OJOS Y PIEL.
NUNCA MIRE LAS LAMPARAS MIENTRAS ESTÁN ENCENDIDAS.
NO DESACTIVE LOS DISPOSITIVOS DE SEGURIDAD.
DESCONECTE EL PODER DEL UVGI ANTES DE REPARAR.

2.7. AIR FILTRATION SECTION

- A. Filters: Filter sections shall be designed for the indicated filter types and orientations. Provide filters that comply with requirements of Sections 234100.
- B. Filter Holding Frames: Provide filter holding frames arranged for flat or angled orientation, with access doors.
 - 1. Frame Material: Galvanized steel
 - 2. Panel Filters: Factory-fabricated filter holding frames arranged for flat or angular orientation as indicated, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - 3. Filter frames shall be set up to utilize the same size filter and not mix matched for each unit. Filter sizes shall be standard filter dimensions, such as 16x20, 16x25, 20x20, or 24x24.
- C. Filter Gage: Provide filter gage to measure pressure loss, 0 to 2-inches w.g., across each filter bank. Flush-mount gages on unit casing directly above filter section access doors. Dwyer "Magnehelic" or equal.
- D. No air handler shall use more than 1 filter size.

2.8. DAMPERS

- A. Leakage Rate: Dampers shall not exceed AMCA 511 Leakage Class 1A, 3 cfm/sqft at 1-inch w.g. pressure differential. Ruskin model CD60 or equal.
 - 1. Isolation Dampers: Refer to Section 233300.
- B. Damper Operators: Comply with requirements in Section 230900.
- C. Electronic Damper Operators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque. Electronic damper position indicator shall have visual scale indicating percent of travel and 2 to 10-V dc, feedback signal.
 - 1. Operator Motors: NEMA Premium Efficient motor, complying with Section 230513, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Permanent split-capacitor or shaded-pole type with gear trains

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- completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Non-spring-return motors for dampers larger than 25 sqft. shall be sized for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 3. Spring-return motors for dampers larger than 25 sqft. shall be sized for running and breakaway torque of 150 in. x lbf.
 4. Size dampers for running torque calculated as follows:
 - a. Parallel-blade dampers shall have running torque based on 7 inch-lb/sqft. of damper with edge seals and 4 inch-lb/sqft. of damper without edge seals.
 - b. Opposed-blade dampers shall have running torque based on 5 inch-lb/sqft. of damper with edge seals and 3 inch-lb/sqft. of damper without edge seals.
 - c. Increase running torque by 1.5 when dampers are exposed to 2 to 3-inches of pressure drop or 1000 to 2500 fpm face velocities. Increase running torque by 2.0 when dampers are exposed to 3 to 4-inches of pressure drop or 2500 to 3000 fpm face velocities.
 5. Coupling: V-bolt and V-shaped, toothed cradle.
 6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 7. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on non-spring-return actuators.
 8. Power Requirements (Two-Position Spring Return): 24 V ac.
 9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 11. Temperature Rating: Minus 22 to plus 122 deg F.
 12. Run Time: 12 seconds open and 5 seconds closed, unless otherwise indicated.
- D. Outdoor and Return-Air Mixing Dampers: Aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Actuate dampers independently and simultaneously. Comply with Section 233300.
1. Outside Air (OA): Parallel blade type.
 2. Return Air (RA): Parallel blade type.
- E. Combination Filter and Mixing Section: Cabinet support members shall hold 2-inch thick, pleated, flat, permanent or throwaway filters. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.9. IDENTIFICATION

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- A. Manufacturer's Name-Plate: Name-plate shall be installed on or near the supply air fan section access door.
- B. Points of Connection: All piping and wiring utilities available for connection at the exterior of the unit shall be clearly identified with permanent labels.
- C. Internal Wiring: All internal wiring shall be clearly identified with permanent labels.

2.10. TESTING

- A. Field Testing: Representatives from the owner, project engineer, and installing contractor may witness the testing if they choose. Provide proposed test procedures for review and coordinate schedule 2 weeks prior to testing. Test results shall be published for review. Units shall pass all quality control testing prior to acceptance.
 - 1. Unit Testing: Perform unit and component testing in the field.
 - a. Casing shall be pressure, leak and deflection tested per AHRI 1350 to meet the minimum requirements defined in "Unit Casings" section above. Deflection criteria shall apply to wall, roof, floor and door panels.

PART 3 - EXECUTION

3.1. DELIVERY

- A. All air handling unit openings shall be protected during shipping and rigging with sheet metal covers. The entire unit including each shipping section shall be wrapped in 7 mils plastic shrink wrap to maintain unit cleanliness.

3.2. EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3. INSTALLATION

- A. Equipment Mounting:
 - 1. Install indoor air-handling units on cast-in-place concrete equipment bases.

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2. Comply with requirements for vibration isolation in Section 230548.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.4. CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect condensate drain pans and extend to nearest discharge location. Discharge to either sanitary sewer floor drain, storm water floor drain, or exterior grade as indicated on plans to meet local regulations. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- D. Connect wash-down drain piping and extend to nearest sanitary floor drain. Install line sized ball valves for each section. The valves shall be closed during unit operation.
- E. Hot and Chilled Water Piping: Comply with applicable requirements in Sections 232113 and 232116. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300.

3.5. 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. Prepare written report summarizing findings and recommended corrective actions prior to start-up. Verify corrections have been made prior to start-up.
- B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

3.6. STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.

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3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that outdoor- and return-air mixing dampers open and close and maintain minimum outdoor-air setting.
 7. Comb coil fins for parallel orientation.
 8. Verify that proper thermal-overload protection is installed for electric coils.
 9. Install new, clean filters.
 10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Manufacturer's Start-up: Factory authorized representative shall perform the air handling unit start-up procedures, including the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7. ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 for air-handling system testing, adjusting, and balancing.
- C. Replace fan and motor pulleys as required to achieve design airflow. Coordinate with the TAB Contractor.

3.8. CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units inside and out. Internally remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9. DEMONSTRATION

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- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

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SECTION 23 82 16 – AIR COILS

PART 1 - GENERAL

1.1. SUMMARY

- A. Section includes heating and cooling air coils.

1.2. SUBMITTALS

- A. Product Submittals: For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.3. QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.
- C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

- A. Performance Ratings: Hydronic coils shall be tested and rated according to AHRI 410 and ASHRAE 33.

2.2. HYDRONIC COILS

- A. Description: Coils shall be factory tested to 300 psig and rated for a minimum working pressure of 200 psig and minimum temperature of 325 deg F. Coil tubes shall be ASTM B 743 seamless copper expanded into fin collars for permanent fin-tube bond and expanded into header for permanent leak-tight joints. Coil fins shall be copper or aluminum. Coil headers shall be cast-iron with drain and air vent tappings for coils 32-inches tall and less and seamless copper tube with brazed joints and prime coated for coils taller than 32-inches. Coil

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casings shall be minimum 16 gauge galvanized steel channel frame for slip-in or flanged mounting.

2.3. DRAIN PANS

- A. Description: Drain pans shall be stainless steel. Alternative materials, such as galvanized steel and plastic, are not acceptable. Construct insulated pans with drain connection at the lowest point(s) and comply with ASHRAE 62.1. Pans shall extend beyond coil length and width, upstream and downstream of coil face, and under coil header and exposed piping

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
- D. Install drain pan under each cooling coil. Connect to condensate trap and drainage.
- E. Straighten bent fins on air coils.

3.3. CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Hydronic Coils: Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 239010 and other piping specialties are specified in Section 232116.

END OF SECTION

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23 90 01 BUILDING AUTOMATION SYSTEMS

PART 1 - GENERAL

1.1. APPLICABLE SECTIONS

- A. 23 90 10 BAS Sensors and Devices

1.2. RELATED DOCUMENTS

- A. The Contract Drawings are directly applicable to this Section, and this Section is directly applicable to them.
- B. The general provisions of the Contract, including General and Supplementary Conditions and/or Division 01 Specification Sections, are directly applicable to this Section, and this Section is directly applicable to them.
- C. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- D. The Request for Proposal and associated Scope of Work are directly applicable to this Section, and this Section is directly applicable to them.
- E. The Owner's BAS Master Plan is directly applicable to this Section, and this Section is directly applicable to it.
- F. Collectively, these items will be referred to as the Contract Documents.

1.3. DEFINITIONS AND ABBREVIATIONS

- A. Where definitions in Division 01 conflict with the definitions herein, Contractor will comply with the most stringent requirement.
- B. BAS Component: a generic reference to any hardware component which is provided by Contractor, including but not limited to controllers, power supplies, transformers, relays, actuators, sensors, or other devices.
- C. Building Automation System (BAS): Also referred to as Building Management System (BMS), Direct Digital Control (DDC).
- D. Building Controller: Controller, which is at, and controlling at, the building-level. Could also be a large portion of a building, such as a wing, depending on hardware capability. Generally, are the middle tier of the overall BAS network, and report up to a Building or Enterprise Supervisor. Also, generally what Device Controllers would be integrated with. See Section 2.5 System Architecture for full definition and specification.
- E. Building-Level Network (BLN): An ethernet, fiber, and/or wireless network dedicated to the BAS, which connects Building Controllers and Building Supervisors. The BLN may be a separate network from Owner's LAN, or as part of the LAN, which has been segmented to be used exclusively by the BAS. See Section 2.5 System Architecture for full definition and specification.
- F. Building Supervisor: Server, which is at, and controlling at, the building-level. Generally used when Building Controllers do not have sufficient hardware capability to support an entire building. Generally, are the middle tier of the overall BAS network, and installed on a Server in lieu of being a stand-alone piece of hardware. Also, generally what Building Controllers would be integrated with. Building Supervisors may be further integrated to an Enterprise Supervisor. See Section 2.5 System Architecture for full definition and specification.
- G. Controller: A generic reference to a BAS Controller, including but not limited to Device Controllers and Building Controllers.
- H. Contract Documents: All documents which compose the project, including but not limited to drawings, specifications, RFPs, scope of work, general conditions, and supplemental conditions.
- I. Control Panels: an assembly composed of an enclosure and one or more BAS Component(s).

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- J. Critical: A special area or zone which receives specialized BAS Components.
 - K. Device Controller: Also referred to as Field-Level Controller. Controller, which is at, and controlling at, at the device-level. Device in this instance is understood to reference MEP Equipment. Generally, are the lowest tier of the overall BAS network, and report up to a Building Controller. See Section 2.5 System Architecture for full definition and specification.
 - L. Device-Level Network (DLN): A copper, ethernet, fiber, and/or wireless network dedicated to the BAS, which connects Device Controllers and Building Controllers. See Section 2.5 System Architecture for full definition and specification.
 - M. Enterprise Supervisor: Server, which is at, and controlling at, the enterprise-level. Generally, are the highest tier of the overall BAS network, and installed on a server in lieu of being a stand-alone piece of hardware. Also, generally what Building Controllers and/or Supervisors would be integrated with. See Section 2.5 System Architecture for full definition and specification.
 - N. Field-Level: See Device Controllers and Device-Level Network.
 - O. Furnish: To supply and deliver to project site, ready for installation.
 - P. Install: To place in position for service or use.
 - Q. Local Area Network (LAN): Ethernet, fiber, and/or wireless network which connects computers and other networkable devices (printers, etc.), and has a connection to the WAN. See Section 2.5 System Architecture for full definition and specification.
 - R. MEP: Mechanical, electrical, and plumbing.
 - S. MEP Equipment: Where MEP Equipment is used, it is understood to mean any piece of MEP Equipment which the BAS will in some way, shape, or form, interface with, via hardwired connection or integration. MEP Equipment includes, but is not limited to VAV, AHU, RTU, split systems, hot water heaters, heat exchangers, boilers, chillers, and pumps.
 - T. Owner: The financial provider and user of the BAS, as well as Owner Representatives.
 - U. Owner Representatives: Representatives for the Owner which are on staff, contracted, or hired to protect the interests of the Owner, such as Engineers, Architects, Commissioning Agents, and other parties.
 - V. Project: The facility/building as defined in the Contract Documents.
 - W. Server: A computer in which BAS software is installed on.
 - X. Sequence of Operation: The steps that MEP Equipment takes to achieve the desired operation to provide optimal comfort and/or ventilation for the Project.
 - Y. Substantial Completion: Written authorization by the Owner that the project has reached a point of completion that it can be utilized.
 - Z. Supervisor: A generic reference to a BAS Supervisor, including but not limited to Building Supervisors and Enterprise Supervisors.
 - AA. Provide: To furnish and install, complete and ready for intended use.
 - BB. Wide Area Network (WAN): Ethernet and/or fiber-based network which connects multiple facilities via the internet. See Section 2.5 System Architecture for full definition and specification.
 - CC. Warranty Period: The time between Substantial Completion and the duration of Warranty, as specified.
- 1.4. GENERAL SPECIFICATIONS
- A. Contractor shall provide all hardware, software, configuration, programming, graphics (GUI), checkout, alarms, trending, functional testing, and commissioning necessary to provide a complete and fully functioning BAS. Contractor shall include all hardware, control wiring, wiring accessories, wiring connections, software, and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system, now and in the future.
 - 1. Provide all necessary BAS Components on each piece of MEP Equipment to:

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- a. Perform the specified Sequence of Operation and meet the design/performance intent of the MEP Equipment.
 - b. Comply with BAS Components as shown on the control diagrams.
 - c. Comply with the point lists.
 - d. Comply with the Specifications herein.
 - e. Comply with the design intent of the BAS.
2. Where the Sequence of Operation, control diagrams, points list, or specifications conflict with each other, Contractor will comply with the most stringent requirement.
- B. It is Contractor's responsibility to review all the Contract Documents and report any discrepancies to Owner.
- C. Substitutions
 1. Wherever the words "approved equal," "for review," or "for acceptance" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of BAS Component for that specified, submit all information pertinent to the adequacy and adaptability of the proposed BAS Component to Owner and secure their approval before the BAS Component is ordered.
- D. Warranty
 1. The entire BAS and all ancillary equipment required for its operation shall be free from defects in workmanship and material under normal use and service. If within twenty-four months from the date of Substantial Completion the installed equipment is found to be defective in operation, workmanship or materials, Contractor shall replace, repair, or adjust the defect at no cost to Owner.
 2. Corrective software and/or hardware modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.
 - a. Modifications made which are corrective to one piece of MEP Equipment will be replicated to all MEP Equipment for consistency in programming.
 - b. User documentation will be updated in all locations, including but not limited to hard copies, Control Panel hard copies, O&Ms, and PDF copies accessible via download inside the BAS system.
 - c. Maintain revision control (i.e., v1_05) to indicate which is the latest version of all documentation, software, and programming.
 3. Owner reserves the right to make changes to the BAS during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any changes made by Owner unless Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.
 4. At no cost to Owner, during the Warranty Period, Contractor shall provide maintenance services for software including all current software updates, firmware, and hardware. Prior to the closeout of the warranty period, Contractor shall meet with Owner to address any questions or concerns and offer ongoing services to Owner.
 5. Electronic Actuators: Parts and labor for 5 years from the date of substantial completion.
 6. Air and Water Flow Meters: Parts and labor for 3 years from the date of substantial completion.
- E. Training
 1. Provide 8 hours of training for Owner personnel, and/or maintenance contractor, on the operation and maintenance of the BAS.
 2. Provide 8 hours of training for Owner personnel, and/or maintenance contractor, on the operation and maintenance of the BAS, 180 days after Substantial Completion.

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3. Provide 1 Niagara Certification class (approximately 40 hour of instruction) for Owner personnel and/or maintenance contractor. Class shall be Tridium-Approved, instructor-led, in-person training. Lodging and expenses will be covered by Owner.

1.5. CODES AND REFERENCE STANDARDS

- A. Comply with all current federal, state, and local codes, requirements, ordinances, and regulations, in accordance with the authorities having jurisdiction (AHJ).
- B. Comply with the National Electric Code (NEC).
- C. Comply with all manufacturer guidelines and requirements.
- D. Comply with all Owner rules, guidelines, procedures and requirements, including Owner IT.
- E. The latest published edition of a reference shall be applicable to the Project unless identified by a specific edition date.
- F. All materials, installation, and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 2. American National Standards Institute (ANSI)
 3. UL 916: Energy Management Systems
 4. LonMark International
 5. BACnet Testing Lab

1.6. COORDINATION OF WORK AND INTEGRATION

- A. Certain LonMark, BACnet, Modbus, and other products, systems, and interface devices, may be provided by other trades via MEP Equipment. Examine the Contract Documents to ascertain the requirements to install, wire, program, commission, and/or interface to these systems. Particular attention must be paid towards the interface boards submitted by the various MEP Equipment providers. It is Contractor's responsibility to verify the submitted interfaces will integrate properly into the BAS. Report any discrepancies to Owner. Discrepancies brought to Owner's attention after the procurement of that piece of MEP Equipment will be integrated at no additional cost to Owner. Contractor will provide additional interface(s) needed to integrate piece of MEP Equipment.
- B. Contractor shall review MEP Equipment for compliance with control diagrams, Sequence of Operation, and points lists. Report any discrepancies to Owner.
- C. Wherever work interconnects with work of other trades, coordinate with other trades and with Owner to ensure that all trades have the information necessary so that they may properly install all the necessary connections and equipment.
- D. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Verify all locations with Owner and/or General Contractor prior to installation.
- E. Coordinate sources of 120V power with the Electrical Contractor and Owner. Extend power from source(s) as needed.
- F. Coordinate location of data ports/drops to the LAN/WAN with the Electrical Contractor and Owner.
- G. Coordinate shipping of BAS Components to another Contractor or manufacturer for factory-installation.

1.7. SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Provide 1 replacement for each unique actuator, Controller, thermostat, wall module, or any other BAS Component provided.

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1.8. QUALITY ASSURANCE

- A. The BAS and BAS Components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.
- B. Control Panels, both new and modified, shall comply with UL 508A or approved testing agency accredited by the North Carolina Building Code Council.
- C. Electrical Components, Devices, and Accessories: UL listed and labeled as defined in NFPA 70 or equivalent by a qualified testing agency marked for the intended location and application and accepted by the AHJ and Engineer.

1.9. CONTRACTOR QUALIFICATIONS

- A. Qualifications may be requested from Contractor prior to the bidding process. Owner reserves the right to not allow Contractors to bid if they do not meet the qualifications or provide them in a timely manner. Qualifications will be provided for all items below in an orderly format for review by Owner.
- B. Contractor shall have a successful history in the design and installation of the BAS being provided that consists of web-browser monitoring and control of LonWorks, BACnet, and/or Modbus Device Controllers. These projects must be on-line and functional such that Owner can observe the BAS in full operation. Include proper references, contact names, emails, and phone numbers of these reference projects, with a minimum of five projects similar to this Project.
- C. Contractor shall demonstrate experience in BAS installations for not less than five years, in BAS installation projects with point counts equal to this Project, and systems of the same character as this Project.
- D. Contractor shall have specialized in and be experienced with the installation of the proposed product line for not less than five years, on at least ten projects of similar size and complexity.
- E. Contractor shall be factory authorized by manufacturer of product line and be in good standing with the manufacturer.
- F. Contractor shall be located within 50 miles of Project.
- G. Contractor shall be a Certified Tridium Systems Integrator.
- H. Contractor shall have a minimum of three, Niagara Technical Certification Program (TCP) certified personnel.
- I. Contractor shall have a minimum of three personnel who are certified in LonWorks, BACnet, and/or Modbus line(s) of controls to be installed as part of this project.
- J. Be of sufficient size to provide service, including both routine maintenance and emergency support within 24 hours upon receipt of request.

1.10. ACTION SUBMITTALS

- A. Product Data Submittal
 - 1. Submit manufacturer's technical product data for each BAS Component, including but not limited to Controller, sensor, actuator, relay and panel, indicating dimensions, capacities, performance, electrical characteristics, and material finishes. Also include installation and start-up instructions.
 - a. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate, mark-through, and highlight only applicable information.
 - b. Generic submittals will be automatically rejected.
 - 2. Submit documentation indicating LonMark, NICs, and/or BTL compliance and include Protocol Implementation Conformance (PIC) Statements.
- B. Shop Drawings Submittal
 - 1. Submit shop drawings. Shop drawings will include:

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2. Bill of Materials (BOM): indicating equipment served, quantity, manufacturer, point range (i.e. 0-10 in. w.c.), sensor range (i.e. 0-10V), and model number for all BAS Components being provided.
 - a. Disconnect Schedule: additionally, indicating MCA, MOP, voltage, # of phases, size, NEMA rating, # of poles, and neutral (Y/N).
 - b. Starter Schedule: additionally, indicating horsepower, voltage, # of phases, size, NEMA rating, and bypass.
 - c. VFD Schedule: additionally, indicating horsepower, voltage, # of phases, size and NEMA rating, bypass (Y/N), number of contactors (if bypass), disconnect (Y/N), and disconnect type (fused/non-fused).
 - d. Hydronic Valves (Pressure-Dependent): additionally, indicating gpm, line size, calculated Cv and design pressure drop, actual Cv and actual pressure drop, close-off pressure, type (ball/globe/butterfly), connection, valve size, 2/3-way, mixing/diverting (if 3 way), service (2-position/modulating), and fail position.
 - A) Actual pressure drop will correct for any line-size to valve-size restrictions per the manufacturer's data.
 - B) Actuator will be scheduled with the valve per the standard BOM.
 - e. Hydronic Valves (Pressure-Independent): additionally, indicating gpm, line size, selected valve gpm, maximum valve gpm, min/max pressure drops, close-off pressure, type (ball/globe/butterfly), connection, valve size, 2/3-way, mixing/diverting (if 3 way), service (2-position/modulating), and fail position.
 - A) Actual pressure drop will correct for any line-size to valve-size restrictions per the manufacturer's data.
 - B) Actuator will be scheduled with the valve per the standard BOM.
 - f. Air Flow Metering Stations (AMFS): additionally, indicating duct size, output, network capable (LonWorks/BACnet), and number of probes/sensors.
 - g. Water/Steam Flow Meters: additionally, indicating line size, output, network capable (LonWorks/BACnet), and flow meter style/type.
 - h. Damper Schedule: additionally indicating, duct size, blade type, leakage, and construction.
 - i. VAV schedule: indicating VAV type, K factor, and max/min/reheat flows.
3. Schematic Flow Diagram: schematic representation of MEP Equipment. Diagram will show all BAS Components on schematic, point name, and point number (i.e. UI-1). Where MEP Equipment varies slightly, schematic will be clearly diagramed to indicate any differences between each piece of MEP Equipment. Stating the schematic as "typical" is not acceptable.
4. Wiring Diagram: indicating power, signal, and control wiring. Where terminal blocks are provided, provide indication where wiring terminates to terminal block.
5. Sequence of Operation: Any modifications proposed to the Sequence of Operation will be clearly marked up as part of the shop drawings or submitted as an annotated Microsoft Word document in addition to the shop drawings. A default Contractor Sequence of Operation, included without regard to the Contract Document's Sequence of Operation, will result in a rejected submittal.
6. Control Panel Diagrams: indicating panel faces, with layouts of any BAS Components to be installed in the panel face, BAS Component locations inside panel, and labeling of BAS Components.
7. One-line diagram for all controllers showing the network layout. Where Project is to connect with an existing BAS, indicate how the new network will integrate with the new and/or existing BAS Components.

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8. Indicate anticipated device ID, Network number, MAC Addressing, and Max Masters for all BACnet devices. Provide logical schema for BACnet addressing.
 9. Individual floor plans with device (controllers, routers, sensors, etc.) locations with all interconnecting wiring routing including space sensors, Device and Building-Level Network wiring, power wiring, and low voltage power wiring.
 10. Additional Requirements:
 - a. Point names will be consistent between the schematics and wiring diagrams.
 - b. Misc. Points List: where controllers being provided for other purposes are also used to control a miscellaneous point, such as an exhaust fan or lighting contactor, provide a list of those miscellaneous points in a concise format for quick identification of their location and associated Controller.
 - c. Provide a complete list of any deviations of submitted products to the specification in this document.
 - d. Where existing BAS Components are being reused, such as controllers or sensors, clearly indicate (via coloring, line type, etc) the BAS Components being reused as “existing” and new components as “new.”
- C. Graphics Submittal
1. Provide screen captures of graphical user interfaces developed by Contractor on previous projects. These screen shots shall represent actual work performed by Contractor and not generic work from the line of controls which Contractor represents. Screenshots will be applicable to the MEP systems as part of this project. “Generic” screenshots of MEP systems will not be accepted. Provide client contact information for Owner to validate. Any comments from the submittal process will be incorporated into the actual graphics for the project.
 2. Follow Owner’s graphics standards.
 3. Zoning Map
 - a. Provide submittal of graphic floorplans for markup by Owner to identify required zoning to use for scheduling. Floorplan markup will be used by Contractor to segment equipment that satisfies the identified zones.
- D. Point-Naming Submittal
1. Points shall be named consistently. Provide list of point names and point conventions.
 2. Point naming shall be consistent with an existing standard, such as Project Haystack.
- E. IP Drop Request Submittal
1. Provide list of BAS Component(s) which need an IP drop to the LAN/WAN.
 2. Provide location, quantity (if multiple per Control Panel/location), and IP address requirements (DHCP, fixed, etc), and total number of IP address reservations, including room for future growth.
 3. Provide list to a minimum of 10 business days’ notice prior to needing the drop.
 4. Contractor will be responsible for cabling and conduit. Owner shall provide final connections.
- F. Schedule/Sequence of Construction Submittal
1. Provide schedule and sequence of construction, as it pertains to the installation of the BAS, for review.
- G. Functional Performance Testing (FPT) Submittal
1. Provide FPT agendas and testing procedures for review.
 2. FPT should include at a minimum Sequence of Operation, point-to-point verification to graphical interface, historical data logging, and alarms testing procedures.

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1.11. START-UP AND ASSOCIATED TESTING SUBMITTALS

A. Point-to-Point Testing/Checkout Sheets Submittal

1. Prior to startup of MEP Equipment, Contractor will provide checkout sheets for each piece of MEP Equipment.
2. Checkout sheets will contain at a minimum:
 - a. Equipment name and location.
 - b. Associated Controller address (MAC or Node ID), name, type, and instance number.
 - c. Point name, type (resistance, amperage, voltage, etc), and range (i.e., -5 to +5 in w.g.).

B. Start-Up Testing Submittal

1. As part of the startup of MEP Equipment, Contractor will provide start-up testing sheets for each piece of MEP Equipment.
2. Start-up testing sheets will contain at a minimum:
 - a. Equipment name and location.
 - b. Sequence of Operation and step-by-step procedure used to check programming and configuration.
 - c. Any modifications required to Sequence of Operation for MEP Equipment performance.
 - d. Final graphical screens.
 - e. PID tuning parameters for each loop.

C. Adjusting and Calibration Submittal

1. As part of the startup of MEP Equipment, Contractor will provide a calibration submittal for each piece of MEP Equipment.
2. Calibration submittal will contain at a minimum:
 - a. Equipment name and location.
 - b. Point name, type, and range.
 - c. Sensor type and manufacturer's stated accuracy.
 - d. Calibration type (single point, two point, etc).
 - e. Checking, adjusting, and calibration data.
 - f. Sensor installed accuracy.
 - g. Sensor pass, fail, replaced, etc.
 - h. Calibration equipment used and associated certificates of calibration, including expiration dates.

1.12. CLOSE-OUT SUBMITTALS

A. Operating and Maintenance Manuals

1. Provide all documentation as required in the submittal processes to-date, updated to as-built conditions.
2. In addition, provide the following:
 - a. Include control response, settings, set points, throttling ranges, gains, reset schedules, adjustable parameters, and limits.
 - b. A table (or similar) of all Testing, Adjusting and Balancing (TAB) values for each piece of MEP Equipment and BAS-calibrated equipment, such as airflow metering stations (AFMS).
 - c. Any O&Ms for equipment not originally included in the submittal, in addition to product data.

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- d. Accurately record actual set points, calibrations/offsets, and settings of controls, final Sequence of Operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
 - e. Database of all point names.
 - B. As-Built Shop Drawings
 - 1. Provide PDF of shop drawings which have been corrected to reflect the as-built state.
 - a. Incorporate any redlines made in field during installation.
 - b. Update Sequence of Operation to reflect MEP Equipment operation as changed during installation, commissioning, and/or functional performance testing.
 - c. Provide reference to being “as-built” version on each sheet of the shop drawings.
 - 2. Provide hard copy of appropriate shop drawing page(s) inside each Control Panel.
 - C. Software Closeout
 - 1. Provide all usernames, passwords, software, GUI, databases, licenses, and application programming tool(s) to Owner.
 - 2. Provide software backup of entire BAS and associated components on digital media for Owner record. Coordinate file location of automatic backup of software with Owner.
 - D. Reference 3.11 Closeout for additional requirements.
- 1.13. MATERIALS AND EQUIPMENT
 - A. All materials shall meet or exceed all applicable referenced standards, federal, state, and local requirements, referenced standards, and conform to codes and ordinances of the AHJ.
 - B. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where Contract Documents specifically allow existing materials to remain in place.
 - C. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.
- 1.14. COLORS AND LABELING
 - A. Where requirements in 230553 conflict with the requirements below, Contractor will comply with the most stringent requirement.
 - B. Provide BAS Components consistent with the following color requirements.
 - 1. Control Panels Blue
 - 2. Conduit Blue
 - 3. Input/Output Wiring Yellow
 - 4. BACnet Copper Wiring Orange
 - 5. LonWorks Copper Wiring Purple
 - 6. Modbus Copper Wiring Blue
 - 7. Ethernet/Fiber Cable Consistent with color of primary communication protocol.
 - 8. Tubing Black with White Stripe
 - C. Provided BAS Components with the following labeling requirements.
 - 1. Controllers
 - a. Vinyl or nylon label, 1/2 inch or greater in height, black text on white background, adhesive backed, printed with MEP Equipment served by Controller, permanently mounted.
 - 2. Control Panels
 - a. Two-layer engraved phenolic or engraver’s plastic tag, 1 inch or greater in height, adhesive backed, engraved with MEP Equipment served by panel, permanently mounted.

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3. Input/Output Wiring
 - a. Nylon or self-laminated wire-wrap label, 1/2 inch or greater in height, black text on white background, adhesive backed, printed with BAS Component connected to cable and cable number, permanently mounted at termination to terminal block in Control Panel on cable jacket.
 - b. Premade labels or wire marker tape is not allowed.
4. BAS Component
 - a. Vinyl or nylon label, 1/2 inch or greater in height, black text on white background, adhesive backed, printed with MEP Equipment served and BAS Component purpose (ex. AHU-1 SF Start/Stop), permanently mounted.

PART 2 - PRODUCTS

2.1. MANUFACTURERS AND VENDORS

- A. Subject to the Specifications and requirements herein, the BAS will be provided by (listed in alphabetical order):
 1. Distech by CMS Controls
 2. Distech by Engineered Control Solutions (ECS)
 3. Honeywell by Engineered Control Solutions (ECS)
 4. Distech by Hoffman Building Technologies (HBT)
 5. Facility Explorer by CCAC Building Solutions (CCAC)
 6. Schneider Controls by Schneider Controls
 7. Lynxspring / Vykon Controls by Brady Trane
- B. Products by the manufacturer listed shall be used for Device and Building Controllers. Sensors, actuators, valves, dampers, and other BAS Components may be manufactured by others as indicated.

2.2. GENERAL

- A. Owner shall receive ownership of all job-specific configuration documentation, data files, software and/or code developed for the Project. This shall include all custom, job-specific software code, databases, and documentation for all configuration and programming that is generated for the Project and/or configured for use with the Device and Building Controllers or Building and Enterprise Supervisors, and any related LAN, WAN, Intranet, and Internet connected routers and devices.
- B. Any and all required IDs and passwords for admin and programming-level access to any BAS Component or software program shall be provided to Owner.
- C. It is Owner's intent to purchase an open system capable of being serviced and expanded by any acceptable system integrator that has and maintains certification to work on Niagara Framework systems. The Niagara Compatibility Statement (NICS) for all Niagara Software shall allow open access and be set as follows: accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*". In any case, Owner shall maintain the right to direct Contractor to modify any software license, regardless of supplier, as desired by Owner.
- D. Contractor shall not install any "brand-specific" software, proprietary JAR files, applications, or utilities on Niagara Framework based devices, unless otherwise permitted. Provide exceptions to Owner for review.
- E. All Device and Building Controllers installed for the project shall not be limited in their ability to communicate with a specific brand of the BAS. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed in replacement of, or in parallel with, existing components.

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- F. Device and Building Controllers shall have the ability to perform energy management routines via preprogrammed function blocks or template programs.
- G. Browser-based access: A remote/local user using a standard browser will be able access all BAS facilities and graphics via the LAN or direct connection, with proper username and password. Only HTML5 browser-based graphical user interfaces (GUI) is acceptable. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer, Edge, Firefox, or Chrome.
 - 1. Graphics shall be Niagara “virtuals” which allow graphics to be present on both the JACE and Supervisor, allowing for an update in one location to be automatically applied to the other.
- H. Remote data access: The system shall support browser-based remote access over the Internet to the building data.
 - 1. The Contractor shall coordinate with Owner IT to ensure all remote browser access is protected with the latest BAS software updates.
 - 2. The Contractor shall coordinate with Owner IT to ensure a VPN (Virtual Private Network) is installed to protect Owner from cyber-attacks.
- I. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a Supervisor server on the LAN. User tools for BLN and/or DLN management shall be provided and licensed to Owner and shall allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations and settings.
- J. Database Schema shall be published and provided to Owner to facilitate easy access to BLN and DLN data.
- K. Owner shall be the named license holder of all software associated with any and all incremental work on the project. Contractor will coordinate with Owner IT for any requirements regarding software/hardware licensing.
- L. Where multiple pieces of Niagara equipment exist, use single-JACE sign-on. Coordinate with Owner on requirements.

2.3. DEVICE COUNT AND SOFTWARE MAINTENANCE AGREEMENTS

- A. All Device Controllers, Building Controllers, and Supervisors which have a license structure to where only a certain quantity of BAS Components or devices can connect to it shall be selected such that there is a minimum 25% capacity for future BAS Component or device connections. (i.e. if there are 80 connected devices, the license shall allow for $80 \times 1.25 = 100$ potential device connections (20 extra device connections possible).
- B. All Building Controllers and Supervisors which have a license structure requiring a Software Maintenance Agreement (SMA) shall be for a period of five years.

2.4. SYSTEM PERFORMANCE

- A. Description: The BAS shall comply with the following minimum performance requirements. Performance requirements are based on a fully functioning BAS with all trends and alarms enabled:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than 2 seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within 6 seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

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2.5. SYSTEM ARCHITECTURE

- A. The system architecture provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications. The Building and Device-Level Network shall be based on industry standard open platforms as specified herein, and utilize commonly available operation, management, and application software. All software packages and databases shall be licensed to Owner to allow unrestricted maintenance and operation of the BAS. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.
- B. Reference 4.1 Network Diagram for diagram of System Architecture layout.
- C. The system architecture shall consist of a Wide Area Network (WAN), a Local Area Network (LAN), a Building-Level Network (BLN), and one or more Device-Level Network(s) (DLN), as well as an Enterprise Supervisor, a Building Supervisor, Building Controller(s), and Device Controller(s), as applicable.
 - 1. Wide Area Network (WAN): WAN infrastructure provided by Owner. Contractor will coordinate with Owner IT for configuration (ports, firewall, etc) for a successful BAS installation.
 - a. The WAN infrastructure shall be used to connect the Enterprise Supervisor to the Building Supervisor and/or Building Controller(s).
 - 2. Local Area Network (LAN): LAN infrastructure provided by Owner. Contractor will coordinate with Owner IT for configuration (ports, firewall, etc) for a successful BAS installation.
 - a. The LAN infrastructure shall be the connection point to the WAN for the BAS, and also serve as the BLN.
 - 3. Building-Level Network (BLN): BLN shall be a segmented network on the Owner's LAN.
 - a. The BLN shall be used for connection of Building Controller(s) and/or Building Supervisor only. No Device Controller(s) shall be connected to the BLN.
 - 4. Device Level Network (DLN): DLN infrastructure provided by Contractor.
 - a. DLN will be BACnet TCP/IP (Ethernet).
 - b. Contractor will provide one or more DLNs to maintain network speeds as specified herein.
 - c. Additional DLNs of a different protocol than listed may be added to integrate unique pieces of equipment not provided by Contractor, however all Contractor-provided equipment shall be consistent with the DLN above.
 - 5. The LAN is existing and segmented for the BLN.

2.6. SYSTEM ARCHITECTURE, ADDITIONAL REQUIREMENTS

- A. Niagara Framework will be Niagara 4 (N4), with the latest stable released installed (as identified by Contractor) and will be compatible with any existing Niagara systems. Where the incorrect software version is installed, it shall be corrected at no additional cost to Owner.
- B. Prior to bid, where a modification to the System Architecture is desired, Contractor will obtain permission for the proposed System Architecture. Contractor will provide documentation with proposed modifications and how they will improve the System Architecture as specified. If not approved, Contractor will provide the System Architecture as specified.
- C. Prior to the bid, Contractor may request for additional connections to the WAN/LAN beyond the ones specified herein. Should those connections be disallowed, Contractor shall provide additional BLN(s) or DLN(s) at no additional cost to Owner.
- D. Capacity of any BLN or DLN shall be limited to 70% of the allowable device count to allow for future minor modifications or expansions to the network. Provide calculations on request.
- E. Device Controllers shall communicate on a hardwired network.
- F. Twisted-Pair Based Device Level and/or Building Level Networks (DLN/BLN):

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1. BACnet MS/TP networks where the baud rate for equipment is “fixed” and cannot be changed shall be segmented from the main DLN(s). The main DLN(s) will not be slowed to accept Device Controllers with slower baud rates than the majority of the Device Controllers can achieve.
 2. ARCnet and/or Token-Ring based DLNs shall not be acceptable.
 3. The communication speed between Device Controllers shall be sufficient to ensure fast system response time under any loading condition. At a minimum, network speed shall be minimally 78K bits per second (LonWorks FTT-10A), 19.2K bits per second (Modbus RTU), 76,800 baud (BACnet MS/TP).
 - a. Where speeds must be reduced, provide justification to Owner for approval.
 4. Provide a maximum of 40 LonWorks FTT-10A controllers per segment. Provide a maximum of 25 BACnet MS/TP controllers per segment. Provide a maximum of 25 Modbus RTU controllers per segment.
 - a. Controller counts may be increased where specifically recommended/approved by the Manufacturer and system performance will be achieved as specified. If network performance suffers due to excessive controllers, Contractor shall provide additional BLN(s) or DLN(s) at no additional cost to Owner.
- G. Ethernet Based Device Level and/or Building Level Networks (DLN/BLN):
1. Where DLN is an ethernet-based network (vs traditional copper twisted-pair network), the requirements of the BLN shall also apply to the DLN.
 2. Ethernet-based BLN or DLN shall be consistent with Owner IT standards and requirements, and at a minimum IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000base-T gigabit Ethernet throughput. Provide all routers, switches, and other hardware for functionality.
- 2.7. DEVICE CONTROLLERS
- A. Provide a new Device Controller for each of the existing Device Controller(s) and/or pieces of MEP Equipment. Coordinate with the RFP and/or Scope of Work. Provide additional Device Controller(s) as required.
- B. General
1. Device Controllers shall fundamentally communicate with the protocol as specified in the System Architecture for the DLN. Device Controllers which communicate over a different protocol and then convert to the specified protocol via a protocol converter, router, or gateway are not acceptable.
 2. All Device Controllers shall be able to communicate peer-to-peer without the need for a Building Controller and shall be capable of assuming all responsibilities typically assumed by a Building Controller.
 3. Any Device Controller shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other Controller connected on the same communication cabling. So called “Slave Controllers” are not acceptable.
 4. A dedicated Device Controller will be provided for each piece of MEP Equipment. Controller “sharing,” where one Controller does one or more pieces of MEP Equipment, is not allowed, unless specifically approved by Owner.
 5. Each Device Controller shall have a minimum of 10% spare capacity for each point type for future point connection, rounded up to the nearest whole number.
 6. Performance
 - a. Each Device Controller shall have a minimum of 64KB of RAM and 384KB of non-volatile flash memory.

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- b. Each Device Controller shall have a 32-bit microprocessor operating at a minimum of 68 MHz.
 - c. Real time clock with rechargeable battery and 20 days power backup.
 - 7. The control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The control program shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 - 8. Provide single Device Controllers with the physical and software resource count for standalone operation of each piece of MEP Equipment. The Sequence of Operation and required points for control shall reside on a single Device Controller.
 - a. Remote I/O modules (via a field-wired communications bus designed for remote I/O purposes) are acceptable for points required to achieve the Sequence of Operation.
 - A) BACnet, LonWorks, Modbus, and any other communication protocol designed for Device Controller to Building Controller communication is not acceptable for remote I/O communication.
 - B) Expansion I/O modules plugged directly into the Controller are acceptable for points required to achieve the Sequence of Operation.
 - C) Additional Device Controllers connected via the DLN are not acceptable for points required to achieve the Sequence of Operation.
 - 9. Device Controllers with integral sensors or devices (i.e., a VAV terminal unit controller with integral damper actuator and pressure sensor), shall comply with the specification requirements for those sensors if they were submitted separately. If the Controller's sensors or devices do not comply, the sensors or devices will be provided separately.
 - 10. BACnet Device Controller Specific Requirements:
 - a. Each BACnet Controller on the BACnet MS/TP communications trunk shall provide a loading characteristic of 1/8th load.
 - b. Provide BACnet Controllers that are BACnet Testing Laboratory (BTL) listed (v14 or later). Controllers will be marked with the BTL certified logos. Controllers must be within the following categories:
 - A) BACnet Building Controller (B-BC)
 - B) BACnet Advanced Application Controller (B-AAC)
 - C) BACnet Application Specific Controller (B-ASC)
 - 11. Modbus Device Controller Specific Requirements:
 - a. Provide Modbus Device Controllers that conform to the Modbus Conformance Testing Program and be independently verified by an approved third-party for conformance.
- C. Configurable Device Controllers
 - 1. Shall contain an application-specific control program which can be configured to meet the Sequence of Operation.
 - 2. Where a configurable Controller cannot be configured to meet the Sequence of Operation, a Programmable Controller will be used. Alternatively, Contractor may submit a request to modify the Sequence of Operation so that a Configurable Controller may be used in lieu of a Programmable Controller.
- D. Programmable Device Controllers
 - 1. Shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications.
- E. Ethernet Device Controllers
 - 1. Provide with a 2-port or greater managed or unmanaged integrated switch.

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2. Controllers should be able to be “daisy chained” to eliminate multiple dedicated ethernet drops for each Controller.
- 2.8. BUILDING CONTROLLERS
- A. Provide Building Controller(s) with sufficient expansions to integrate DLNs while maintaining network speed, point count requirements, spare capacity, and other requirements as specified.
 - B. Building Controller(s) shall be JACE 8000 series.
 1. Provide with embedded workbench.
 2. Provide with all required expansions for LonWorks FTT-10A, RS485, etc. to achieve the necessary quantity of DLN(s).
 - C. Provide sufficient quantity of Building Controllers to maintain average processing power at 70% or less. Where Building Controllers are running above 70% consistently, additional Building Controllers will be provided and DLNs rewired at no cost to the Owner.
- 2.9. BUILDING SUPERVISORS
- A. Where there is a single Building Controller, no Building Supervisor is required.
 - B. In lieu of a Building Supervisor, use Enterprise Supervisor.
 1. No computer will be installed onsite as part of the Project.
 2. For graphics that spread over multiple Building Controllers, build inside Enterprise Supervisor and link to corresponding Building Controller(s) (ex., master floorplan graphic inside Enterprise Supervisor, with hyperlinks to IPs for Building Controllers in each wing).
- 2.10. ENTERPRISE SUPERVISORS
- A. Integrate Building Supervisor and/or Building Controller(s) to the existing Enterprise Supervisor.
- 2.11. CONTROL PANELS AND ENCLOSURES
- A. Control Panels are an assembly composed of an enclosure and one or more BAS Component(s). Control Panels will be provided for:
 1. All MEP Equipment which requires a Device Controller(s) and does not have an Enclosure for a Device Controller(s) included as part of the MEP Equipment.
 2. All Building Controller(s).
 - B. Reference 1.8 Quality Assurance for Control Panel rating requirements.
 1. All Control Panels provided for MEP Equipment shall be assembled and installed in accordance with UL508A. Field wiring to the Control Panel shall be terminated to a field wiring terminal as indicated on the required drawings provided with the Control Panel.
 - C. Controller(s) installed inside of MEP Equipment shall only be done so in spaces/enclosures designed for a Controller to be installed (i.e. a VAV controls enclosure). The fact a Controller fits inside the space does not constitute being designed for a Controller to be installed. Controller shall not be installed on the outside of any MEP Equipment or in a plenum, even if Controller is plenum rated.
 - D. Enclosures shall have continuously welded and ground smooth seams, have doors that open 180 degrees, concealed and continuous hinge, and ground studs on door and body.
 - E. Indoor/inside enclosures shall be NEMA/UL Listed Type 1. Enclosure shall be powder-coated steel, consistent with color chart herein. Outdoor/outside Enclosures shall be NEMA/UL Listed 3R or 4X. Enclosure shall be power-coated steel consistent with color chart herein or stainless steel.
 - F. All enclosures will be provided with a removable backplate to which BAS Components will be fastened. No BAS Components will be fastened to the enclosure body. BAS Components, such as pilot lights and switches, displays, and operator interfaces may be mounted to the enclosure door, so long as they are designed to do so. No component will sacrifice or downgrade the NEMA rating of the enclosure.

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- G. Control Panels will be sized (width, height, and depth) so that all BAS Components, including but not limited to Controllers, relays, power supplies and transformers, fit inside neatly and in an organized fashion. Provide cable tray for all wire to rest in and fasten to backplate. Cable tray shall be sufficiently sized for future expansion and/or service loop for field-wiring.
- H. Control Panels which have more than one BAS Component are required to be provided prewired to numbered terminal blocks. All BAS Components and terminal blocks will be fastened to the removable backplate and wired between the BAS Components and terminal block at Contractor's panel shop. The terminal block will serve as the demarcation point between factory/shop wiring and field wiring. At no point shall field wiring cross the terminal block and be wired directly to a factory/shop-installed BAS Component. Any BAS Component that was intended to be in the field, such as a relay, will not be installed inside the Enclosure in the field.
 - 1. Exception: Enclosures which house only one BAS Component, such as a Controller, are not required to have numbered terminal blocks, and may have field wiring terminated directly to the BAS Component.
- I. Maintain separation between Class 2 wiring and other wiring, such as power, for both field and factory connections.
- J. The design intent of the Control Panels is to have the ability to, in the future, disconnect all field wiring from the terminal blocks, remove the backplate with old control components, install new backplate with new control components and reconnect wire to the terminal blocks. Contractor will maintain design intent with their panel design and installation.
- K. Where the Specification conflicts with Control Panel requirements specifications, Contractor will comply with the most stringent requirement.

2.12. CABLE, WIRING, TUBING, AND ACCESSORIES

- A. BAS cable for input and outputs shall comply to the color chart herein and have "BAS CABLE" (or equivalent) physically written on the cable from the cable manufacturer at regular intervals.
- B. BAS cable for LonWorks shall comply to the color chart herein and have "LONMARK" physically written on the cable from the cable manufacturer at regular intervals. BAS cable for BACnet shall comply with the color chart herein and have "BACNET" physically written on the cable from the cable manufacturer at regular intervals. BAS cable for other protocols will have the appropriate protocol written on the cable.
- C. All control wiring and tubing shall be plenum rated, no riser cable or tubing is allowed. Conform with NFPA 262 Flame Test for approved plenum use without conduit.
- D. Provide with integral ripcord.
- E. Treat cable with a lubricant to increase cable pulling productivity and efficiency and to decrease the risk of cable damage due to excessive pulling strengths. A non-staining lubricant shall be applied to coat the full length of the cable during the manufacturing process. The lubricant shall produce a low coefficient of friction on the cable jacket material that reduces pulling friction by up to 70%. The lubricant shall continue to reduce friction after it has dried; remaining as a slippery film that retains lubricity for months after use. The cable lubricant shall comply with the physical and performance requirements of Telcordia Standard, TR-NWT-002811, and Generic Requirements for Cable Placing Lubricants. The lubricant shall not contain solvents nor have a flash point.
- F. BACnet and Modbus cable will be continuously shielded. LonWorks cable must be shielded into and out of VFDs, or any other noise-generating piece of equipment. Ethernet cable, regardless of protocol, must be shielded into and out of VFDs, or any other noise-generating piece of equipment. Input/output (I/O) cable need not be shielded.
- G. Ethernet cable shall comply with the color chart herein and be consistent with Owner IT standards and requirements, and at a minimum IEEE 802.3 Category 6 cable.

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- H. Tubing for air pressure sensors shall be polyethylene, approved for plenum installations, have high stress-crack resistance and be resistant to ultraviolet light.

2.13. TRANSFORMERS AND DC POWER SUPPLIES

A. Control Transformers

- 1. Class 2, sized and rated for application. Circuit breaker overcurrent protection; fused or internal overcurrent protection is not allowed. Transformers shall be sized so that connected load does not exceed 75 percent of rating. Functional Devices TR series or approved equal.

B. DC Power Supplies

- 1. Class 2, sized and rated for application. Overcurrent protection with auto-reset; fused or internal overcurrent protection is not allowed. Transformers shall be sized so that connected load does not exceed 75 percent of rating. IDEC PS5R-V Series or approved equal.

2.14. SURGE PROTECTION

- A. Provide any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BAS Components.
- B. All BAS Components shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.
- C. Provide Control Panel surge protection for:
 - 1. Building Controllers and/or their associated Control Panels
 - 2. Control Panels with 11 or more hardwired input/output points entering/exiting the panel.
 - 3. Control Panels with network routers, switches, and/or other network/interface devices.
 - 4. Location(s) required by Owner based on submitted controls architecture.
 - 5. Manufactured by Ditech DTK-120HW or approved equal.
- D. Provide surge protection for DLN and/or BLN at every point network enters or leaves the building enclosure.
 - 1. Manufactured by Ditech DTK-2MHLP series or approved equal for copper twisted-pair networks.
 - 2. Manufactured by Ditech DTK-110C6A series or approved equal for ethernet networks.

2.15. SWITCHES

- A. Provide network switches inside Control Panels as required for BLN and/or DLN communications.
- B. Manufactured by Contemporary Controls Skorpion Switch Series or approved equal.

2.16. SOFTWARE

- A. Provide one copy of Tridium Niagara Workbench software.
- B. Provide one copy of ALL programming tools for all Device Controllers. Provide multiple versions of Software as required. Software will be fully licensed and not a “partial” or “light/lite” software version. Any functionality the Manufacturer and/or Vendor has available to them will also be provided to the Owner.
- C. Install software on Owner-chosen computer. Coordinate with Owner on processing, memory, operating system, and other computer requirements.

PART 3 - EXECUTION

3.1. PREPARATION

- A. Examine areas and conditions under which BAS is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner and Contractor. Report any issues to Owner and/or General Contractor.

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- B. These Specifications call out certain duties of Contractor and any subcontractor(s). They are not intended as a material list of all items required by the Project.

3.2. INSTALLATION

- A. Provide related items and work indicated in the Contract Documents, as specified or not specified, necessary to provide a complete and fully functioning BAS, including but not limited to:
 - 1. All incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc.
 - 2. All BAS Components, devices, power supplies, transformers, fittings, sensors, controllers, wiring, accessories, etc.
 - 3. All wiring, including communication network, analog points, digital points, low voltage power, line voltage power, emergency power, etc.
 - 4. All associated power and low voltage connections.
 - 5. All conduit, junction boxes, fittings, panels, enclosures, hardware, etc.
- B. Utilize licensed electricians for all electrical distribution systems.
- C. The Contract Documents show the general arrangement of the respective systems. Follow as closely as actual building construction and the work of other trades will permit.
- D. Maintain redlines of shop drawings throughout installation process. Redlines will be used to generate O&Ms, and any other closeout documentation as specified herein. Shop drawings for O&Ms which are submitted unchanged from the Action Submittal phase will be required to be as-built to actual constructed conditions at no cost to Owner.

3.3. PRODUCT DELIVERY, STORAGE, HANDLING, PROTECTION, AND CLEANING

- A. All products and materials shall be new, clean, and free of defects, damage, and corrosion.
- B. Ship and store products and materials in a manner which will protect them from damage, weather, and entry of debris until final acceptance.
- C. Where BAS Components are required to be factory-mounted on MEP Equipment by others, arrange for shipping of BAS Components to MEP Equipment manufacturer.

3.4. SITE CLEAN-UP

- A. At conclusion of each day's work, and at the request of Owner, clean up and remove from the site all rubbish, debris, and trash accumulated during the day as a result of work of Contractor.
- B. Marks on walls and/or ceiling tiles caused by Contractor shall be cleaned by Contractor.
- C. Ceiling tiles, drywall, carpet, paint, and all architectural finishes damaged by Contractor shall be replaced by Contractor.

3.5. POWER WIRING, CONTROL WIRING, AND CONTROL TUBING

- A. Extend 120V power circuits from points provided to control voltage transformers. Where dedicated junction boxes have been provided, coordinate the exact locations with the Electrical Contractor. Where they have not, coordinate the spare circuit breakers to be used with the Electrical Contractor and/or Owner.
- B. Install all wiring and tubing in conduit.
 - 1. Exception: Class 2 wiring and tubing may be installed exposed in rated plenum spaces where exposed plenum cable and tubing is appropriate. Install all BAS wiring and tubing in dedicated BAS J-hooks; no wiring or tubing will be run with other low-voltage cables (such as Owner IT cable tray). Tie cables and tubing together and to J-hook (if open style, not required if has built-in fastener).
- C. Install wire, cable, and accessories with sufficient slack and flexible connections to allow for vibration of piping and equipment.

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- D. Wire safeties and limit controls to prevent operation of MEP Equipment in any selector position (off-hand-auto).
- E. Provide sleeves and conduit for passage of wiring through structural masonry, concrete walls and floors, and elsewhere for the proper protection of the BAS. Seal as required.
- F. Splices are not permitted within the BLN or DLN communication cables. Only continuous network topologies or continuous homeruns are allowed for these networks. Splices identified, including damage to cable, will result in cable being re-pulled at no additional cost to Owner.
- G. Limit DLN and BLN cable lengths to no longer than 70% of the longest dimension published by the manufacturer of the cable or Controller, between the most remote network nodes/Controllers.
- H. Shielded wiring will have shields twisted together and taped against jacket of cable. No exposed shields will be allowed. Ground shield at one end of cable.
- I. LonWorks communication network shall transition from unshielded to shielded at device prior to VFD(s), be shielded into and out of the VFD(s), and transition back to unshielded at device after VFD(s).
- J. Power wiring, control wiring, and wiring accessories (i.e. conduit) shall be consistent with color chart herein.
- K. Power wiring, control wiring, and wiring accessories shall comply with specifications. Where the Specification conflicts, Contractor will comply with the most stringent requirement.
- L. Install control transformers and DC power supplies inside Control Panels. Transformers randomly installed in plenum, or connected to junction box via nipple mount, is not allowed.
- M. Install surge protection for wiring as required. Surge protection for 120V shall be installed exterior to Control Panel. Surge protection for communication network will be installed in close proximity to grounding locations and bars. Route communication network such that surge protection can be installed in accordance with manufacturer's instructions. Excessive grounding wiring runs and/or grounding to structural steel for surge protection is not permitted.
- N. Maintain all bend radius requirements with control tubing. Do not kink tubing. Do not use tees, elbows, or other fittings in tubing.
- O. I/O wiring shall be labeled in accordance with 1.14 Colors and Labeling. Wire number shall correspond to wire number shown on Closeout Documentation.
- P. I/O cabling will be sized in accordance with the load and distance traveled. Input wiring will be minimally 22AWG. Output wiring will be minimally 18AWG.

3.6. NETWORK MANAGEMENT FUNCTIONAL REQUIREMENTS

- A. Contractor shall thoroughly and completely program and configure BAS Components, software, supplemental software, application programming, network communications, operator workstations, computers, printer, and network communications to permit the functional requirements of the BAS herein specified. The setup shall include as a minimum the following network management procedures:
 - 1. Automatic backup of the BAS database to appropriate media.
 - 2. Program, load, and debug all software installations, including integration of third-party applications (i.e., analytics and energy management).
 - 3. Network user auditing routine.

3.7. POINT-TO-POINT TESTING/CHECKOUT

- A. As a part of installation, provide checkout (also called point-to-point testing) of all BAS Components.
- B. Prior to start-up of any MEP Equipment, ensure all points have been properly set up, including but not limited to sensor type and range.
- C. Ensure BAS Component is accessible for maintenance.

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- D. Ensure sensors and devices have been installed in the correct location in accordance with actual field conditions and modifications made to the flow diagram in the Contract Documents. Ensure sensors and devices have the proper flow direction, orientation, insertion depth, and any other applicable requirements.
- E. Provide means to increase or decrease sensed value and ensure the BAS responds accordingly.
- F. Checkout will be performed via Owner's final graphic screens. If checkout is performed within the programming function of the BAS, it shall be repeated when the final graphic screens are complete and available for use.
- G. Check operation of valve/damper-actuator combination to confirm that actuator modulates valve/damper smoothly throughout stroke to both open and closed positions. Check valve for proper close off.
- H. Provide documentation of the checkout process for each piece of MEP Equipment.

3.8. START-UP TESTING

- A. At the conclusion of point-to-point testing/checkout, provide start-up testing of all BAS Components.
- B. Provide start-up of all MEP Equipment. Perform start-up in conjunction with any applicable trades.
- C. Provide start-up testing to ensure all configuration and programming conforms with Sequence of Operation.
- D. Start-up testing will be performed via Owner's final graphic screens. If start-up testing is performed within the programming function of the BAS, it shall be repeated when the final graphic screens are complete and available for use.
- E. Tune PID's to provide reasonable speed response to change in variables while having stable operation.
- F. Provide documentation of the start-up testing process, including any modifications made to the Sequence of Operation, for each piece of MEP Equipment.

3.9. ADJUSTING AND CALIBRATION

- A. Adjust and calibrate all points on the BAS as follows.
- B. Prior to calibration, complete all point-to-point testing/checkout and start-up testing to ensure the BAS is fully functioning.
- C. Calibrations shall be made inside the Niagara wire sheet. Do not calibrate sensors inside the device controller.
- D. Calibrated instrument shall be minimally twice as accurate as the sensor's installed accuracy.
- E. Using calibrated instruments, document actual value (per calibrated instrument) and indicated sensor reading (per the BAS). Adjust using a single point offset or a double-point calibration. Document calibration value(s).
- F. If sensor reading is within the manufacturer's stated accuracy, do not calibrate the sensor. Document actual value and sensor reading.
- G. If sensor is greater than manufacturer's stated accuracy, investigate installation of sensor (i.e., 5-10 pipe/duct diameters downstream, etc), programming of sensor (i.e., SVNTs, range, voltage instead of mA and resistance causing high voltage drop, etc.), transient issues (i.e., turbulence, diffuser blowing on sensor). If investigation uncovers potential source of error, correct sensor installation.
- H. If no errors are found and sensor's accuracy is between 100 and 200% of manufacturer's stated accuracy, provide:
 - 1. Single-point offset for sensors whose readings will vary less than 20% (ex., room temperature).
 - 2. Two-point calibration for sensors whose readings will vary greater than 20%.
 - 3. Document actual value, sensor reading, and offset/calibration values.

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- I. If no errors are found and sensor's accuracy is greater than 200% of manufacturer's stated accuracy, replace sensor. Alternatively, provide documentation for approval as to why sensor's error is more than 200% of manufacturer's stated accuracy.
- J. Work with Testing and Balance (TAB) Contractor to input calibrations performed within TAB Contractor's scope of work. Provide dedicated personnel to assist TAB Contractor during their work, provide a fully functioning TAB graphical screen on the BAS for TAB Contractor use, or provide means to adjust TAB via wall module. Assist TAB Contractor with questions regarding TAB graphical screen.
- K. Do not calibrate any sensor which has a guaranteed installed accuracy, such as airflow monitoring stations (AFMS) or water flow sensors.

3.10. FUNCTIONAL PERFORMANCE TESTING (FPT) PROCEDURE

- A. Perform point-to-point testing/checkout, start-up testing, adjusting/calibration testing, configuration, and programming on all MEP Equipment and the BAS as a whole to provide a complete and fully functioning BAS.
- B. BAS shall be complete and fully functioning prior to any Functional Performance Testing (FPT). Assist Owner and/or Owner Representatives, which may include but is not limited to the Engineer, Architect, Commissioning Agent (CxA), and/or Testing and Balance (TAB) Firm, with FPT, which may include but is not limited to verification, commissioning, and/or Graphical User Interface (GUI) acceptance testing. Provide dedicated personnel to those activities as specified herein or as requested by Owner.
- C. Provide documentation as specified to prove the BAS is complete and fully functional prior to FPT activities.
- D. At a minimum, perform the following FPT procedures. The following may be achieved within a Commissioning Plan or another FPT as required within the Contract Documents.
 - 1. Provide Owner an agenda and schedule of FPT activities for approval and coordination as part of Action Submittals.
 - 2. Complete all necessary installation to have a complete and fully functional BAS. Provide written notice that BAS is ready for FPT.
 - 3. Demonstrate BAS systems to Owner. Perform FPT including but not limited to Sequence of Operation, point-to-point verification to graphical interface, historical data logging, and alarms.
 - 4. Owner to provide detailed punch list to Contractor.
 - 5. Contractor to repair issues on Owner punch list within five business days.

3.11. CLOSEOUT

- A. Upon completion of Functional Performance Testing (FPT), Contractor provides all requirements as specified in 1.12 Close-Out Submittals to Owner.
- B. Contractor trains Owner on all aspects of the BAS including architecture, devices, software, and final Sequences of Operation.
- C. Owner issues letter to Contractor declaring that system is Substantially Complete. Date of this letter starts the Warranty Period.
- D. Final Acceptance. Owner issues letter to Contractor accepting system. Final pay app can be issued for release of any remaining contingency funds.

3.12. CONTROL PANELS

- A. Install Control Panels at locations in accordance with the Contract Documents and/or Owner. Ensure proper service clearances will be achieved at the end of construction. Control Panels without proper service clearances will be relocated at no cost to Owner.

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- B. For any Control Panel that exceeds 16 inches in any dimension, provide a trough above/below Control Panel. Trough shall be separated into high and low voltage. Provide a high and low voltage conduit or nipple between trough and Control Panel, sized appropriately for the high and low voltage wiring. All other conduit that serves the Control Panel shall enter/exit the trough. Do not terminate any other conduit(s) to the Control Panel outside of two conduits/nipples identified.
- C. Provide a service loop for all controls wiring. Service loop will be installed in trough (where provided) or inside Control Panel cable tray (where allowed).
- D. Contractor shall extend power to the Control Panel from a junction box or an acceptable location (coordinate with Owner and/or Specifications).

3.13. GRAPHICS/OPERATOR INTERFACE

- A. The graphics shall comply with the Owner's requirements and/or Master Plan.

3.14. RETROFIT WORK, ADDITIONAL REQUIREMENTS

A. Control Panels

- 1. Where existing control panels are to be reused, provide control panel design which facilitates the reuse of wiring without needed to be extended (ex: install terminal blocks across top of control panel backplate to allow for minimal need for extending wiring).
- 2. Where wiring must be extended to reach, wiring will be spliced in a permanent fashion (i.e., solder and heat shrink). Wire nuts in the control panel are not allowed.
- 3. Where the existing control panel does not facilitate an installation that otherwise would require excessive extending of wire, the existing panel can be used as a "patch panel" via terminal blocks.
- 4. Where there is no existing trough or control panel, comply with specifications and install a new control panel and/or trough.

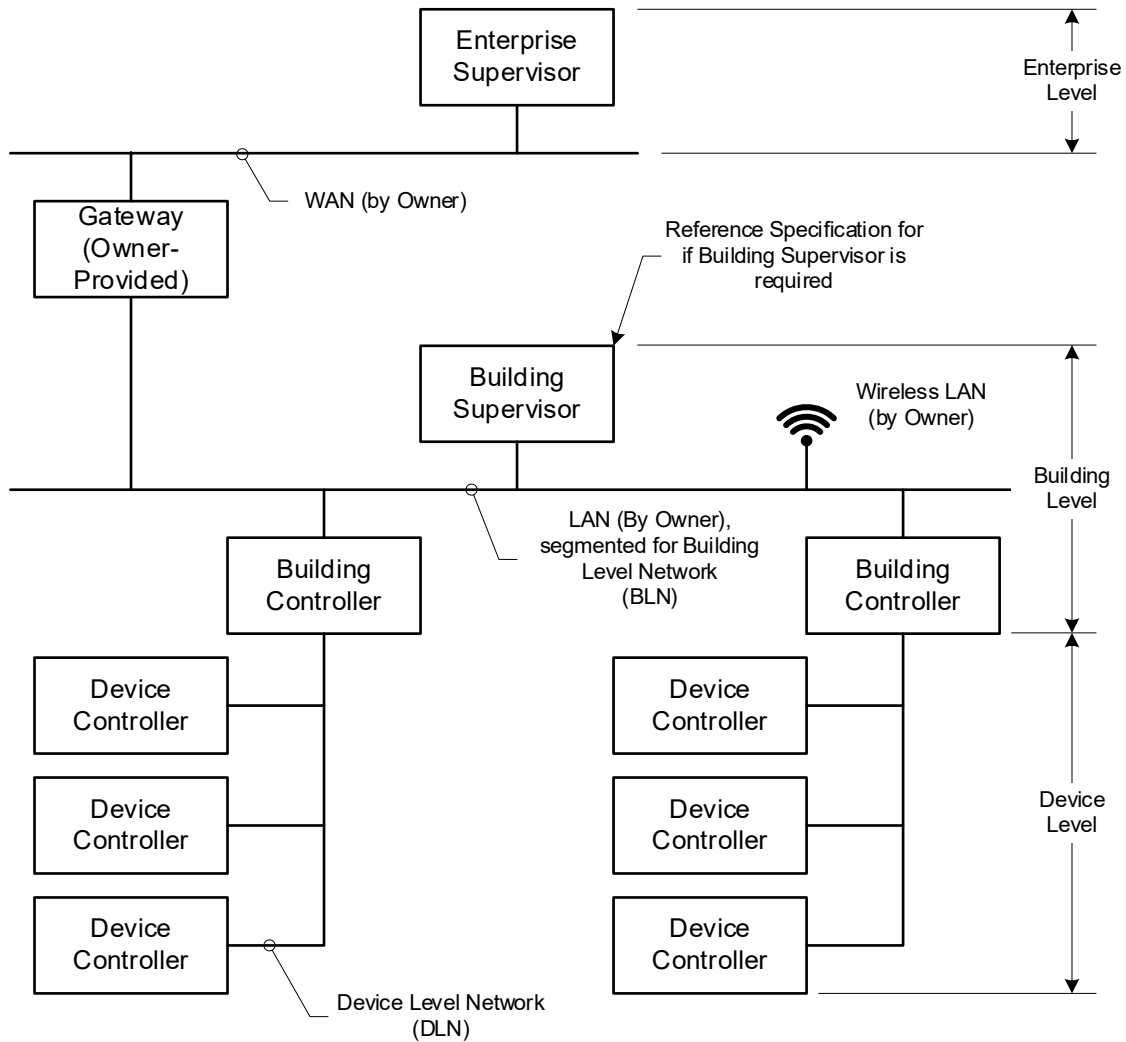
B. General

- 1. Damaged wire, splices from previous work, or any other rework required will be performed as part of the base bid.

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PART 4 - FIGURES

4.1. NETWORK DIAGRAM



END OF 23 90 01 BUILDING AUTOMATION SYSTEMS

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23 90 10 BAS SENSORS AND DEVICES

PART 1 - GENERAL

1.1. APPLICABLE SECTIONS

- A. 23 90 01 Building Automation Systems

PART 2 - PRODUCTS

2.1. GENERAL

- A. Provide BAS Components as indicated in the Contract Documents, Sequence of Operation, control diagrams, points lists, Specifications, or as needed to perform the intended operations consistent with the design intent of the BAS and design/performance intent of the MEP Equipment.
- B. Provide with metal enclosure for all plenum applications. Any sensor mounted in plenum that has a plastic enclosure will be rated for plenum installation or installed in a plenum-rated enclosure.
- C. All sensors shall be vibration and corrosion resistant.
- D. Accuracy statements are written for the specific sensor. Installation shall not degrade accuracy more than double what accuracy statement for sensor requires.
- E. Enclosures:
 - 1. Provide suitable enclosure for BAS Component for ambient conditions encountered by application.
 - 2. NEMA Type 1 or 2 for indoor and protected applications.
 - 3. NEMA Type 3R, 4 or 4X for outdoor and unprotected applications.

2.2. TEMPERATURE SENSORS, STANDARD ACCURACY

- A. Manufacturers:
 - 1. ACI
 - 2. BAPI
 - 3. Distech
 - 4. Honeywell
 - 5. JCI
- B. General Requirements:
 - 1. Sensor shall be thermistor or RTD inherently compatible with BMS.
 - 2. Accuracy: ± 0.5 deg F over 32 to 158 deg F range.
 - 3. Operating Temperature Range: -40 to 300 deg F.
- C. Outside Air Temperature (OAT) Sensor: Sensor installed in wall-mounted weatherproof enclosure with conduit entrance, with PVC sun and windscreen as required.
- D. Duct-Mounted Single-Point Temperature Sensor: Rigid sensor sealed in 0.25-inch stainless steel probe of length between one-third and two-thirds of the duct width in duct-mounted metal housing with conduit entrance.
- E. Duct-Mounted Averaging Element Temperature Sensor: Multi-point sensor, contained in a flexible copper or woven continuous metallic sheath, with length sized for duct.
 - 1. Provide a minimum of 1 foot of sensing element for every three square feet of duct/coil area. Multiple averaging elements may be required.
 - 2. Averaging elements shall be used where ducts are prone to stratification, and downstream of heating/cooling coils.

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3. Where multiple sensors are provided, sensors may be wired in a series-series, parallel-parallel pattern (requires four or nine sensors) in lieu of multiple inputs.
 4. Plenum rated sheaths are not acceptable.
 - F. Wall-Mounted Flat-Plate Temperature Sensor: Stainless steel, flat plate sensor that fits in a standard 2-inch by 4-inch junction box with tamperproof screws. Provide with insulated back.
 - G. Thermowell-Mounted Immersion Temperature Sensor: Rigid sensor sealed in 0.25-inch stainless steel probe, with three-part moisture protection system, that has minimum length of 20% of the pipe width. Provide machined, single-piece brass or stainless steel thermowell compatible with sensor housing.
 - H. Strap-On Piping Temperature Sensor: Sensor with metal clamps to fasten to piping. Strap-on sensors are only acceptable where specifically called for in Contract Documents. Thermowell and insertion sensor shall be installed where strap-on temperature sensor not specifically called for.
 - I. Cooler/Freezer Temperature Sensor: Use bullet probe style sensor.
- 2.3. TEMPERATURE SENSORS, MATCHED PAIR
- A. Where two temperature sensors will be used together to calculate a BTU measurement, provide a matched pair.
 - B. General Requirements
 1. All requirements for Standard Accuracy Temperature Sensors are applicable, except where more stringent below.
 2. Sensor shall be thermistor or RTD with matched transmitter, bath calibrated, 4-20mA output proportional to temperature range and compatible with BAS and 24 Vac/dc power supply.
 3. Differential Accuracy: ± 0.15 deg F at 70 deg F.
 4. Measurement Range: 32 to 200 deg F.
 5. Range of sensor output shall be appropriate for the application the sensor is installed in. Range of the output shall be set at the factory and shown on the provided documentation.
- 2.4. HUMIDITY SENSORS, STANDARD ACCURACY
- A. Manufacturers
 1. ACI
 2. BAPI
 3. Distech
 4. Honeywell
 5. JCI
 - B. General Requirements:
 1. Laser-trimmed thermoset polymer-based capacitive-type sensor, 4-20mA or 0-10Vdc output proportional to relative humidity range of 0% to 100% and 24 Vac/dc power supply.
 2. Accuracy: ± 2 percent over 10 to 90 percent range.
 3. Measurement Range: 0-100%.
 4. Operating Temperature Range: -40 to 140 deg F.
 - C. Outside Air Relative Humidity (OAH) Sensor: Sensor installed in wall-mounted weatherproof enclosure with conduit entrance, with PVC sun and windscreen as required.
 - D. Duct-Mounted Relative Humidity Sensor: Sensor in duct-mounted plenum-rated housing with conduit entrance.
 - E. Wall-Mounted Relative Humidity Sensor: Sensor in white plastic enclosure with insulated back.

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2.5. COMBINATION RELATIVE HUMIDITY AND TEMPERATURE SENSORS

- A. Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, provide combination relative humidity and temperature sensors. The individual sensors must each meet the specifications details herein.
- B. Where required in the drawings, combination relative and humidity sensors shall have the ability to output additional parameters, including dew point, enthalpy, and wet bulb temperature.

2.6. WALL MODULES AND ROOM SENSORS, STANDARD ACCURACY

- A. General
 - 1. Wall modules and room sensors cover devices which mount on a wall and provide an interface between the MEP Equipment and the occupant.
- B. Manufacturers: Provide a wall module consistent with the manufacturer providing the overall controls.
- C. General Requirements:
 - 1. Wall modules which measure including but not limited to temperature, relative humidity, and/or carbon dioxide must each meet the specifications details herein.
 - 2. Provide with plastic enclosure with display, override switch, override indicator, and setpoint adjustment.

2.7. DRY (AIR) PRESSURE SWITCH

- A. Manufacturers
 - 1. Dwyer
 - 2. Cleveland Controls
 - 3. Setra
 - 4. JCI
- B. General Requirements
 - 1. Diaphragm pressure switch with SPDT contacts.
 - 2. Sensor shall be uni-directional.
 - 3. Manual or automatic reset, in accordance with Contract Documents.
 - 4. Setpoint adjustment knob.
 - 5. Accuracy: ± 2 percent of full scale output.
 - 6. Measurement Range: 0 to 12 in wg.
 - 7. Operating Temperature Range: -4 to 185 deg F.
- C. "Paddle-style" air flow switches are not allowed. Use dry pressure switch in lieu of paddle.

2.8. DRY (AIR) PRESSURE SENSOR, STANDARD ACCURACY

- A. Manufacturers
 - 1. ACI
 - 2. Honeywell
 - 3. Setra
 - 4. Veris
- B. General Requirements
 - 1. Diaphragm pressure transducer and amplifier type sensor, 4-20mA or 0-10Vdc output proportional to pressure range and compatible with BMS system and 24 Vac/dc power supply.
 - 2. Sensor shall be uni- or bi-directional for application as stated below.
 - 3. Sensor shall have local display.
 - 4. Accuracy: ± 1 percent of full-scale output/selected range.

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5. Measurement Range: See applications below.
 6. Operating Temperature Range: -4 to 140 deg F.
 7. Burst pressure: 5 psid.
 - C. Duct-Mounted Static Pressure Sensors:
 1. Uni-directional.
 2. Measurement Range: 0 to 5 in wg. for low and medium pressure applications and higher as required for high pressure applications.
 - D. Room Pressure Sensors:
 1. Bi-directional.
 2. Measurement Range: -0.2 to 0.2 in wg.
 3. Provide with surge damper (Amphenol SD-01 or equivalent) and room static pressure pickup with fine stainless steel mesh filter.
 - E. Building Pressure Sensors:
 1. Bi-directional.
 2. Measurement Range: -0.2 to 0.2 in wg.
 3. Provide outside air reference kit, (Dwyer A-306 or equivalent), with tubing, mounting bracket and required hardware.
 4. Provide with surge damper (Amphenol SD-01 or equivalent) and room static pressure pickup with fine stainless steel mesh filter.
 - F. Air Filter/Coil Differential Pressure Sensors:
 1. Uni-directional.
 2. Measurement Range: 0 to 2 in wg and higher as required.
 3. Provide with static pressure probe(s).
- 2.9. WET (WATER) PRESSURE SWITCH
- A. Manufacturers
 1. Ashcroft
 2. Veris
 3. Setra
 - B. General Requirements
 1. Diaphragm pressure switch with SPDT contacts.
 2. Sensor shall have stainless steel wetted components in a weatherproof wiring housing.
 3. Sensor shall be uni-directional.
 4. Manual or automatic reset, in accordance with drawings.
 5. Setpoint adjustment knob.
 6. Accuracy: ± 2 percent of full scale output.
 7. Measurement Range: 0 to two times the setpoint or anticipated pressure.
 8. Operating Temperature Range: -20 to 150 deg F.
 - C. "Paddle-style" water flow switches are not allowed. Use wet pressure switch in lieu of paddle.
- 2.10. WET (WATER) PRESSURE SENSOR
- A. Manufacturers
 1. Ashcroft
 2. Senva

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3. Setra
 4. Veris
 - B. General Requirements
 1. Diaphragm pressure transducer and amplifier type sensor, 4-20mA or 0-10Vdc output proportional to pressure range and 24 Vac/dc power supply.
 2. Sensor shall have stainless steel wetted components in a weatherproof wiring housing.
 3. Sensor shall be uni-directional, unless bi-directional required for reversing flow.
 4. Sensor shall have local display.
 5. Accuracy: ± 0.25 percent of full-scale output/selected range.
 6. Measurement Range: See applications below.
 7. Operating Temperature Range: See applications below.
 8. Proof Pressure: two times rated input pressure, or greater.
 9. Burst Pressure: five times rated input pressure, or greater.
 - C. Water "Gauge" Pressure Sensors:
 1. Measurement Range: 0 to two times the setpoint or anticipated pressure.
 2. Operating Temperature Range: 0 to 175 deg F.
 - D. Water Differential Pressure Sensors:
 1. Measurement Range: 0 to two times the setpoint or anticipated pressure.
 2. Operating Temperature Range: 0 to 175 deg F.
 - E. Provide with four or five valve manifold. Sensor to be connected to manifold at factory.
- 2.11. CURRENT SWITCHES/TRANSDUCERS
- A. Manufacturers
 1. ACI
 2. Setra
 3. Veris
 - B. General Requirements
 1. Sensor shall be rated for their associated motor load and voltage, have input and output isolation, and have LED indication of status.
 2. Sensor shall be selected based on application, including but not limited to standard 60 hertz motors, variable speed drive, or ECM.
 3. Accuracy: ± 2 percent of full-scale output.
 4. Measurement Range: 0 to two times the anticipated current.
 5. Operating Temperature Range: 5 to 140 deg F.
 - C. Current Switch (CS):
 1. Self-powered current switch with N.O. contacts.
 2. Provide with adjustable trip point where indicated in Contract Documents, or as required for proper operation for application.
 - D. Current Transducer (CT):
 1. Sensor with 4-20mA or 0-10Vdc output proportional to current draw and 24Vac/dc power supply.
- 2.12. CARBON DIOXIDE SENSORS
- A. Manufacturers
 1. Honeywell

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2. Vaisala
 3. Veris
 - B. General Requirements
 1. Non-dispersion infrared (NDIR) type sensor, 4-20mA or 0-10Vdc output proportional to carbon dioxide (CO₂) range and 24 Vac/dc power supply.
 2. Sensor shall have local display.
 3. Accuracy: ± 2 percent of reading, or 30 ppm, whichever higher.
 4. Measurement Range: 0 to 2000 ppm.
 5. Operating Temperature Range: 32 to 122 deg F.
 6. Standard Calibration: No maintenance or periodic sensor replacement needed. The sensor shall have a 5-year calibration interval, utilizing an automatic unoccupied period calibration.
 - C. Wall-Mount Carbon Dioxide Sensors: Sensor with plastic enclosure that fits on a standard 2-inch by 4-inch junction box.
 - D. Duct-Mount Carbon Dioxide Sensors: Sensor with sampling tube, duct-mounted metal housing with conduit entrance.
 - E. Where CO₂ is provided beside temperature and/or humidity sensors, it shall be provided separately and not combined into a single sensor.
- 2.13. AIRFLOW MEASUREMENT STATION (AFMS)
- A. Manufacturers
 1. Ebtron
 2. Air Monitor Corporation
 3. Paragon Controls
 - B. General Requirements
 1. Thermal dispersion type flow sensor, composed of one or more sensor probes (multiple sensors per probe) and transmitter, 4-20mA or 0-10Vdc output proportional to flow range and 24 Vac/dc power supply.
 2. Measurement will be made using the principle of thermal dispersion. Provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node. Thermal dispersion devices that indirectly heat a thermistor are not acceptable. Other measurement technologies are not acceptable.
 3. Sensor probe tubes and mounting brackets shall be constructed of gold anodized, 6063 aluminum alloy, 304 stainless steel, or 316 stainless steel.
 4. Internal wiring in probes shall be resilient to exposure of moisture and not effect sensor operation.
 5. Sensor probe shall be comprised of multiple sensors, with calibration data stored in the cable connecting plug, such that switching transmitters will automatically read corresponding calibration and sensor data. Quantity of sensors per probe and quantity of probes shall vary based on duct/fan configuration to provide the required accuracy.
 6. Accuracy: ± 3 percent of reading over full scale, when installed in accordance with manufacturer guidelines. ± 5 percent of reading over full scale for outdoor air intakes, when installed in accordance with manufacturer guidelines. Accuracy is for installed air flow monitoring sensor, not for individual sensors in each probe.
 7. Measurement Range: 0 to 5,000 feet per minute (fpm).
 8. Operating Temperature Range: Probes: -20 to 160 deg F. Transmitter: -20 to 120 deg F.
 9. Sensing elements will be NIST traceable.
 10. Transmitter:

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- a. Heavy-duty construction with LED display with 4-20mA air flow and temperature output signals. Outputs may be field configured for additional signals.
 - b. Capable of communicating with BAS on communication protocol as specified in 239001.
 - c. Transmitter shall generate alarms for individual sensor errors and transmit over the BMS network.
 - d. Transmitter will be provided with Bluetooth low-energy interface card, capable of transmitting information to Android or iOS devices.
- C. Duct Air Flow Measuring Stations: Probes will be ordered specific to duct as installed in field.
- D. Fan Inlet Air Flow Measuring Stations: The sensing element shall be specifically designed to measure air flow of a centrifugal fan at the inlet cone. Coordinate mounting style with fan selection and manufacturer recommendations. For double-inlet fans, provide one set of elements for each inlet.
- 2.14. ZONED DAMPER AND VAV AIRFLOW MEASUREMENT STATION (AFMS)
- A. Manufacturers
 - 1. Kele FXP Series
 - 2. KMC SSS-1000 Series
 - 3. Air Concepts FXP Series
 - 4. Dwyer PAFS-1000 series
 - 5. Existing terminal box manufacturer
 - B. General Requirements
 - 1. Applicable for rectangular or round duct diameters from 4" to 16".
 - 2. Provide duct mounted insertion AFMS in the inlet section for each zone damper or VAV without existing airflow measuring station.
 - 3. Provide with 0.25" ID polyethylene tubing or sizing compatible with connection size from connection to device controller. Provide union adapter as needed.
 - 4. Install in ductwork with integral flange and gasket to prevent leakage.
 - 5. Provide duct mounted multi-point averaging diamond Flow Sensor. Aluminum construction. Supplied with balancing tees. Compatible with terminal box manufacturer.
 - 6. Probes will be ordered specific to duct as installed in field. For maximum measurement accuracy, install the longest sensor that will fit in the duct.
 - 7. Install via manufacturer's instructions.
- 2.15. INSERTION ELECTROMAGNETIC WATER FLOW METERS
- A. Manufacturers
 - 1. Onicon F-3500 Series or approved equal.
 - B. General
 - 1. Provide with NIST traceable, wet calibrated flow-measuring element, integral transmitter (4-20mA or 0-10Vdc output proportional to flow range), installation valves, depth gage, calibration certificate, and attached tag indicating calibration information.
 - 2. Flow meter shall be wet tappable, allowing insertion and removal from the flow stream without system shutdown.
 - 3. Provide power from 24 Vac/dc power supply.
 - 4. Contractor shall be responsible for selecting flow meter options submitted based on application. Flow meter shall be constructed, calibrated, and scaled for the intended application in terms of pipe size, pipe material, installation requirements, expected flow rate, ambient conditions, and

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fluid characteristics which include but are not limited to pressure, temperature, conductivity, and viscosity.

5. Electromagnetic sensing element shall utilize two sets of diametrically opposed electrodes to measure the average flow rate velocity.
6. 316L stainless steel construction.
7. Maximum pressure rating: 400 psig or greater.
8. Maximum temperature rating: 200°F or greater.
9. Accuracy: ± 1 percent of reading from 2 to 20 fps, when installed in accordance with manufacturer guidelines.
10. Flow range: 0 to 20 fps
11. Provide with installation kit appropriate for application.

C. Application

1. All hydronic flow meters.

2.16. INLINE ELECTROMAGNETIC WATER FLOW METERS

A. Manufacturers

1. Onicon F-3200 Series

B. General

1. Provide with NIST traceable, wet calibrated flow-measuring element, integral transmitter, calibration certificate, and attached tag indicating calibration information.
2. Provide with ANSI class 150 or 300 flanges.
3. Contractor shall be responsible for selecting flow meter options submitted based on application. Flow meter shall be constructed, calibrated, and scaled for the intended application in terms of pipe size, pipe material, installation requirements, expected flow rate, ambient conditions, and fluid characteristics which include but are not limited to pressure, temperature, conductivity, and viscosity.
4. Electromagnetic sensing element shall utilize two sets of diametrically opposed electrodes to measure the average flow rate velocity.
5. Flowmeter shall consist of epoxy painted carbon steel outer body, 304 stainless steel flow tube and integral liner to be selected based on operating temperature and fluid.
6. Remote mountable transmitter with display. Display shall provide instantaneous flow rate information, totalized flow information, flow velocity, flow direction, short term trend data and shall be factory configured for a specific flowmeter application.
7. Power Supply: 24 VAC/DC, 12VA max.
8. Measurement Range: in gpm, for range appropriate for application. Do not convert fps to gpm in BAS.
9. Output Range: 0-10V, 4-20mA.
10. Accuracy, when installed in accordance with manufacturer guidelines:
 - a. ± 0.2 percent of reading from 1.6 to 33 fps.
 - b. ± 0.0033 fps at < 1.6 fps.
11. Transmitter Environmental Operating Range: 4 to 140°F.
12. Transmitter Enclosure Rating: IP67 or NEMA 4X.
13. Maximum Pressure Rating: 580 psig or greater.
14. Maximum Temperature Rating: 266°F or greater.
15. Flow Range: 0.1 to 33 fps.

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C. Application

1. All hydronic applications, including domestic cold water.

2.17. BTU (ENERGY) METERS

A. Manufacturers

1. Onicon System 10 or approved equal.

B. General

1. Water flow meter, dual temperature sensors, and transmitter, 4-20mA or 0-10Vdc output proportional to flow range and each temperature (3 analog outputs total), and 24 Vac/dc power supply.
2. Provide water flow meter in accordance with the specification herein.
3. Provide matched temperature sensors in accordance with the specification herein.
4. Transmitter
 - a. Provide with local display and operator interface. Display shall visually indicate instantaneous flow rate, supply temperature, return temperature, thermal energy flow rate (MBH).
 - b. Capable of communicating with BAS on communication protocol as specified in 239001.

2.18. THERMOSTATS

A. Manufacturers

1. ACI
2. Distech
3. Honeywell
4. JCI
5. Schneider Electric

B. General

1. Label switches "FAN ON-OFF", "FAN HIGH-LOW-OFF", "FAN HIGH-MED-LOW-OFF", or as applicable.
2. Mount on standard junction box.
3. Thermostat portion must meet the specifications details herein as required for application.

C. Digital Stand-Alone Thermostat

1. Electronic, solid-state, microcomputer-based room thermostat.
2. Automatic switching from heating to cooling.
3. PID control to minimize overshoot and deviation from setpoint.
4. Set up for four separate temperatures/periods per day, with individual programming for each day of the week (4 programs per day, 7 days per week, 28 potential programs).
5. Instant override of setpoint for continuous or timed period from 1 hour to 31 days.
6. Short-cycle protection.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keypad disable, and fan on-auto-circulate.
8. Powered off unit 24Vac transformer, with solid-state memory in which programming is retained on power failure. Battery acceptable only for time and date upkeep during power failure.
9. Thermostat display features include the following: time of day, actual room temperature, programmed temperature, programmed time, duration of timed override, day of week, and system mode indications include "heating," "cooling," "off," "fan auto," "fan circulate," and "fan on."

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10. Combination Thermostat, Humidistat, Carbon Dioxide, and/or Occupancy Sensor: Where there is a requirement for a thermostat with humidistat, carbon dioxide, and/or occupancy sensing functions at the same location, provide combination unit. The individual sensors must each meet the specifications details herein.
 11. Provide remote sensing element (electronic sensor) as required for application.
 - D. Low-Voltage, On-Off Thermostats
 1. 24Vac, bimetal-operated, mercury-free, heat anticipator, concealed set-point adjustment, space temperature indicator, 55 to 85 deg F setpoint range, and 2 deg F maximum differential.
 2. Selector Switch: Integral, manual on-off-auto.
 - E. Line-Voltage, On-Off Thermostats
 1. Line voltage listed for electrical rating, bimetal-operated, mercury-free, open contact or bellows-actuated, snap-switch or equivalent solid-state type, heat anticipator, concealed set-point adjustment, space temperature indicator, 55 to 85 deg F setpoint range, and 2 deg F maximum differential.
 2. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 3. Selector Switch: Integral, manual on-off-auto.
 4. Combination Thermostat and Fan Switches: Push-button or lever-operated fan switch.
 - F. Freezestat/Low-Limit Duct Thermostat (LTD)
 1. Manual reset switch.
 2. Snap-acting SPDT with gas/refrigerant filled copper capillary that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint. Sensing range 15 to 55 deg F.
 3. Bulb Length: Sized for duct/coil with minimum 5 feet.
 4. Quantity: Provide a minimum of 1 foot of sensing element for each square foot of duct/coil area. Multiple Low-Limit Thermostats may be required.
 - G. High-Limit Humidistat
 1. Snap acting SPDT, duct or room mount, automatic reset switch that trips if humidity sensed is equal to or above setpoint. Sensing range 15 to 95% relative humidity.
 - H. Strap-On Piping Aquastat Temperature Sensor
 1. Snap acting SPDT, pipe mount, automatic or manual reset switch (as indicated in Contract Documents) that trips if temperature sensed is equal to or above setpoint. Sensing range appropriate for application.
- 2.19. RELAYS
- A. Manufacturers
 1. IDEC
 2. Functional Devices
 3. Veris
 - B. General Requirements
 1. Electrically rated for application, minimally SPDT with 10A (resistive) contacts.
 2. Provide with LED indicator light.
 3. Provide with hand-off-auto (HOA) unless otherwise specified. HOA not required if controller has internal HOA or output being controlled has HOA (i.e. VFD).
 4. Plenum rated where required.

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- C. BAS Panel-Mounted Relays: “ice-cube” / socket style with mounting base and replaceable relay. Relays in panel will be screw terminal terminations; relays with wiring whip from factory are not allowed for panel mounting.
- D. Nipple-Mounted Relays: enclosed relay compatible with conduit knockout. Acceptable for field use. With or without factory-provided wiring whip.
- E. Track-Mounted Relays: acceptable for use in terminal unit control panels. Screw terminal terminations. Track-mounted relays are not to be installed in field unless inside an equipment control panel (i.e., no track-mounted relays in electrical boxes).
- F. Combination Motor Starter / Current Switch Relays: allowed only for single-phase equipment and must be mounted such that pilot light is exposed (i.e., combination motor starter / current switch relays which install inside of motor starter/VFDs are not allowed). The individual sensors must each meet the specifications details herein.

2.20. ADDITIONAL SENSORS AND DEVICES

- A. Shaft-Mounted Limit Switches: SPDT/DPDT mercury-free, gravity-actuated mechanical switch with adjustable shaft connection.
- B. Whisker Limit Switches: SPDT/DPDT mechanical whisker switch with adjustable trim arm.
- C. Condensate Drain Pan Overflow Safety Switch: Low-voltage, float-type safety switch designed for condensate drain pan high-level alarm for unit shutdown and alarming. Little Giant Pump/Franklin Electric (ACS series) or equal. Whisker switch with foam float is not acceptable.
- D. Water Leak Detection Alarm: Adjustable-height multi-point water detection sensor constructed to be corrosion and abrasion resistant and configured for normally open or normally closed as required by the application with 24Vac/dc power supply. Provide remote-mounted sensing probe and cable as needed for each application. Operating Temperature Range: -40 to +185 deg F.
- E. Emergency Stop Buttons: ADA-compliant, red emergency pushbutton in yellow polycarbonate plastic enclosure with clear flip-up cover and stainless steel backplate. Button shall be reset by twisting or pulling out the button; a procedure that requires disassembly or a key is not acceptable. 120V or 24 V as needed. Provide label with indication of operation (ex. “Boiler E-Stop”). Safety Technology International (STI) Stopper Station series or equal.
- F. Occupancy Override Spring Wound Timer Switch: Commercial single gang wall SPST timer switch with brushed nickel finish. Provide time cycle up to 6 hours and no hold function. Provide label with indication of operation (ex. “Main Gym HVAC”). Intermatic FF series FF6H or equal.

2.21. ELECTRONIC ACTUATORS

- A. Manufacturers: All valve actuators shall be supplied from a single manufacturer. All damper actuators shall be supplied from a single manufacturer. Provide actuators manufactured by one of the following:
 - 1. Belimo
 - 2. Honeywell
 - 3. Johnson Controls
 - 4. Schneider Electric (TAC Dura-Drive)
- B. General
 - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2. Actuators shall operate related valve(s)/damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the valve/damper is subjected.
 - 3. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the designed pump/fan shutoff pressure as a minimum requirement.

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4. Select actuators to fail in desired position in the event of a power failure. See Contract Documents for power failure modes.
5. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
6. Type: Motor operated, with gears, electric and electronic.
7. Voltage: 24Vac unless otherwise specified. 120V actuators may be allowed if coordinated by BAS Contractor with Electrical Contractor to provide local disconnect and power. Circuit must be fed from the same power panel as the MEP Equipment or Control Panel and a spare circuit must be available.
8. Power: Contractor is responsible for sizing control transformers based on the VA of the actuator(s) selected.
9. Provide electronic overload protection throughout the entire operating range in both directions.
10. Coupling: V-bolt and V-shaped, toothed cradle. Bolt and set screw method of attachment is unacceptable.
11. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
12. Two-Position Actuators: Single direction, spring return or non-spring return type.
13. Modulating Actuators:
 - a. Capable of stopping at all points across full range and starting in either direction from any point in range.
 - b. Control Input Signal:
 - A) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input, the actuator remains in the last position.
 - B) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0-5Vdc, 0-10Vdc, 1-5Vdc, 2-10Vdc, and 4-20mA signals.
 - c. Floating control actuators shall be allowed only for damper and valve control for room terminal units where there is not a room pressurization requirement. See General Requirements for definition of those spaces. Use of floating controls must be specifically requested by Contractor for specific spaces and reviewed by Owner. Submission of floating control actuators without specific comment by Contractor for spaces and the resulting review by Owner does not constitute approval for use.
 - d. Pulse width modulation (PWM), or any other analog signal that is not specified above is not allowed.
14. Position Feedback: Where indicated, equip two-position actuators with auxiliary switches (SPDT) for remote monitoring of open and/or closed position. Point of open and/or closed position can be adjusted over the actuators range of operation (0-100%). Where indicated, equip modulating actuators with a position feedback through current and/or voltage signal for remote monitoring.
15. Fail-Safe: Where indicated, provide actuator to fail via a mechanical spring return mechanism, to drive controlled device to an end position (open or close) on loss of power. Electronic fail-safe is not allowed, unless specifically reviewed and accepted by Owner. Provide external, manual gear release on non-spring return actuators.
16. Temperature Rating:
 - a. Standard Dampers and Valves: -22 to +122 deg F.
 - b. Smoke Dampers: -22 to +250 deg F.
17. Provide actuator enclosure with a heater and thermostat where required by application.

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18. Stroke Time:

- a. Normal: 120 seconds or less from fully closed to fully open, or fully open to fully closed.
- b. Fast-Acting: 12 seconds open, 5 seconds closed unless otherwise noted.

C. Damper Actuators

1. The total damper area operated by an actuator shall not exceed 80 percent of damper manufacturer's maximum area rating.
2. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison off a single control signal.
3. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
4. Use shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
5. Actuator will mount directly to damper with coupler as described above. No foot mount kits, jackshafts, or linkages shall be used.
6. Sizing: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sqft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sqft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sqft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sqft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1,000 to 2,500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2,500 to 3,000 fpm: Increase running torque by 2.0.

D. Smoke and Combination Fire/Smoke Damper Actuators

1. Actuator shall come connected to damper as a rated assembly, sized per the damper manufacturer's requirements, and meet the specifications herein.
2. Actuators operating in smoke control systems shall comply with governing code and NFPA requirements.

E. Valve Actuators

1. Valve actuators will be direct coupled "rotary-style" unless otherwise specified. Where required, direct coupled "linear-style" actuators may be used.
2. Sizing
 - a. Hydronic: Size for torque required to achieve valve close off at 150% of maximum pump differential pressure.

2.22. CONTROL VALVES

A. General

1. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Control valves assemblies shall be provided and delivered from a single manufacturer as a complete assembly, with the actuator installed at the factory.
3. Control valves shall be two- or three-way as specified in Contract Documents.
4. Provide with extended neck as required to accommodate insulation thicknesses.
5. Refer to Division 23 for general information about valve construction and installation.

B. Hydronic Ball-Style Control Valves

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1. Manufacturers
 - a. Belimo (CCV Series)
 - b. Honeywell (VB Series)
 - c. Schneider Electric (VBB/VBS Series)
 - d. Griswold (Unimizer Series)
 - e. Schneider Electric (VBB/VBS Series)
 - f. Johnson Controls (VG1000 Series)
 2. Construction
 - a. 2-Inch NPS and Smaller: 350 psi at 250 deg F brass/bronze body, stainless steel ball with matching blow-out proof stem, full port with stainless steel or composite characterizing insert, Teflon seats, dual EPDM O-ring seals, solder or threaded ends.
 - b. 2 1/2-Inch NPS and Larger: 175 psi at 250 deg F iron body, stainless steel ball and matching blow-out proof stem, full port with stainless steel or composite characterizing insert, Teflon seats, dual EPDM O-ring seals, ANSI Class 125/150 flanged ends.
 - c. ANSI class IV seat leakage for two-way, ANSI class IV seal leakage for three-way A-Port and class III for B-Port.
 3. Flow Characteristics
 - a. Two-way two-position valves shall be full port.
 - b. Two-way modulating valves shall have equal percentage characteristics.
 - c. Three-way valves shall have equal percentage characteristics on A-Port and linear characteristics for B-Port. Bypass applications shall have linear percentage characteristics.
 4. Sizing
 - a. Two Position: Line size or size using a 1 psig pressure differential.
 - b. Two-Way Modulating: Size using 4 psig or equal to the load pressure drop, whichever is greater.
 - c. Three-Way Modulating: Size using 4 psig or equal to the load pressure drop, whichever is smaller.
 - d. Effective Cv: for any valve smaller than line size, the pressure drop due to the reduction in pipe size shall be taken into effect. Provide effective Cv on submittal.
- C. Hydronic Butterfly-Style Control Valves
1. Manufacturers
 - a. Belimo (HD Series)
 - b. Honeywell (VFF Series)
 - c. Schneider Electric (VF Series)
 - d. Johnson Controls (VF Series)
 2. Construction
 - a. 2 to 12-Inch NPS: Class 125/150 cast-iron full-lugged body, stainless steel disc, EPDM seat and extended neck. Disc-to-stem connection shall utilize an internal spline.
 - b. 14-Inch NPS and Larger: Class 125/150 cast-iron full-lugged body, stainless steel disc, EPDM seat and extended neck. Disc-to-stem connection shall utilize a dual-pin method.
 - c. Leakage: 200 psid zero leakage for 2 to 12-inch NPS and 150 psid zero leakage for 14-inch NPS and larger.
 3. Sizing
 - a. Two Position: Line size or size using a 1 psig pressure differential.

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- b. Two-Way Modulating: Size using 3 psig or equal to the load pressure drop, whichever is greater. Size for the design flow with the disc at 60-degree open position and the design velocity less than 12 FPS.
 - c. Effective Cv: for any valve smaller than line size, the pressure drop due to the reduction in pipe size shall be taken into effect.
- D. Pressure-Independent Hydronic Ball-Style Control Valves
 - 1. Manufacturers
 - a. Belimo (PIQCV up to 3/4"; ePIV for 1" and up)
 - b. Bell & Gossett Ultra Setter
 - c. Griswold (MVP Series)
 - d. Flow Control Industries, Inc (Delta P Series)
 - e. Schneider Electric (Space Logic Series)
 - 2. General
 - a. Valve shall meet all the requirements set forth in the Hydronic Ball-Style Control Valve section, in addition to the requirements below.
 - b. Operating Differential Pressure Range: 5 to 50 psid or better.
 - c. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow.
 - 3. Construction
 - a. Mechanical pressure regulation style PIC valves shall have factory installed pressure/temperature test ports (Pete's Plugs) across the pressure regulator at the factory.
 - b. Pressure independent control valves 1" NPT or larger may use ultrasonic flow measurement. The ultrasonic flow meter will meet the specifications herein.
 - 4. Flow Characteristics: see Hydronic Ball-Style Control Valves.
 - 5. Sizing
 - a. Valve shall be sized at line size for the GPM specified of MEP Equipment.
 - b. Provide minimum and maximum full-open pressure drop of valves.

PART 3 - EXECUTION

3.1. GENERAL INSTALLATION

- A. Install aspirating guards on wall-mounted devices in the following locations:
 - 1. Building entrances.
 - 2. Public areas.
 - 3. Where indicated on construction documents.
- B. Exposed wire nuts, including in plenum, will not be acceptable. All connections will be made inside a rated enclosure.
- C. Install labels and nameplates to identify control components according to Specifications.
- D. Install hydronic instrument wells, valves, and other accessories according to Specifications.
- E. Install refrigerant instrument wells, valves, and other accessories according to Specifications.
- F. Smoke detectors, high and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

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- G. Coordinate fire alarm relay connections to the fire alarm system with the fire alarm installer.
- H. Where sensors have a display, mount such that display can be read from ground.
- I. Install sensors in visible and accessible areas. Do not hide sensors on top of ductwork or insulate over sensors.
- J. For sensors on rigid insulation for duct or piping, install sensor prior to insulation. Sensors installed after insulation will be required to cut and seal insulation around sensor.
- K. Sensors requiring an external power source shall use DC power from switching DC power supply. Do not use alternating current for sensors unless specifically required by the manufacturer. Do not use on-board DC power for sensors unless specifically required by the manufacturer.

3.2. TEMPERATURE/HUMIDITY/WALL MODULE AND ROOM SENSORS INSTALLATION

- A. Verify location of thermostats, humidistats, and other exposed control sensors with Contract Documents and room details before installation. Install devices 48 inches above the floor per ADA requirements. The location(s) to be selected by Owner. No sensor shall be mounted until the Owner and/or Owner Representatives give specific location instructions. Do not install sensor(s) on the inside of exterior building walls (including column fur outs) unless explicitly approved by Owner.
- B. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- C. Install outdoor air temperature and humidity sensors on north-facing wall at designated location. If sensor cannot be placed on north wall, submit RFI for approved location and provide with PVC sun shield and windscreen.
- D. Single-point temperature sensors may be used in ducts where there is no air stratification possibilities. Sensor shall be mounted sufficiently downstream to allow for sufficient mixing, five to ten duct diameters at a minimum.
- E. Install mixing plenum sensors in a serpentine manner horizontally (not vertically) across duct. Support each bend with a capillary clip.
- F. Thermowells to be installed in piping. Contractor to “stub-up” any thermowell which is too long to install directly into piping. Install heat-conducting fluid in thermowell prior to installing sensor.
- G. Install heat-conducting fluid where strap-on temperature sensors contact piping. Sand and clean piping prior to installation. Insulate around sensor.
- H. Install cooler/freezer sensors in rubber clamp to isolate sensor from surrounding metal. Run conduit inside cooler/freezer for sensor away from door and storage racks. After sensor has been checked out, seal all penetrations with low expansion insulating foam. Coordinate installation with cooler/freezer vendor.
- I. Install humidity sensor in areas where relative humidity will not rise above 90% RH. If area will have high humidity consistently, relocate to different area and use dewpoint/ psychrometric calculations to calculate relative humidity of the area required.
- J. Wall Modules
 - 1. Limit setpoint adjustment to ± 3 deg F unless otherwise specified on the Drawings.

3.3. PRESSURE SENSOR INSTALLATION

- A. Supply (Positive) Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube/probe. Make pressure tap connections according to manufacturer's recommendations.
- B. Return (Negative) Duct Static Pressure. Pipe low-pressure tap to duct using a pitot tube/probe. Make pressure tap connections according to manufacturer's recommendations.
- C. Room Pressure: Pipe appropriate pressure sensor port (positive space: high pressure, negative space: low pressure) to room. Pipe opposite pressure point to reference outside of room. Connect to stainless steel mesh snubber mounted to white 2 in by 4 in plate at locations on drawings.

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- D. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through outside air reference kit. Mount kit per manufacturer's instructions. Pipe high-pressure port to stainless steel mesh snubber mounted to white 2 in by 4 in plate at locations on drawings.
- E. Pressure transducers, except those controlling VAV boxes, shall be located in Control Panels, not on MEP Equipment or on ducts. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
- F. Do not install tees for TAB purposes in air pressure tubing. Remove tees where found.
- G. Install differential pressure sensor valve manifold at eye level. Provide hard copper tubing from water mains to valve manifold; soft copper not allowed. Provide isolation valves in tubing prior to valve manifold.

3.4. CURRENT SWITCHES/TRANSDUCER INSTALLATION

- A. Wire may be "wrapped" around CS/CT to obtain better status indication.
- B. CS/CTs requiring commissioning/startup will be done per manufacturer installation instructions.

3.5. AIR FLOW MEASUREMENT STATIONS (AFMS) INSTALLATION

- A. Install AFMS in locations indicated and required to perform the Sequences of Operation. Install AFMS in accordance with the manufacturer's recommendations.
- B. Do not install AFMS sensors and probes until all sanding and grinding activities are complete to protect them from accumulating dust and debris.
- C. Prior to ordering, measure actual duct size as installed in field and provide to vendor.
- D. Mount transmitter at eye level. Measure distance from probe to transmitter and order wire whip of sufficient length to reach. Install probe wire whip in conduit of sufficient size for connector to pass through.

3.6. THERMOSTATS

- A. Install Freezestat/Low-Limit Duct Thermostat (LTD) in ducts and plenums in a serpentine manner horizontally (not vertically) across duct. Support each bend with a capillary clip. Provide rows at 12 inch spacing; the element covers a maximum of 6 inches above and below sensing element. At the bottom of the duct or plenum, the row with the tail end of the sensing element shall be a maximum of 6 inches from the bottom.

3.7. WATER FLOW AND BTU METER INSTALLATION

- A. Install water flow meters in locations indicated to perform the Sequences of Operation. Install water flow meter in accordance with the manufacturer's recommendations.
- B. Do not install AFMS sensors and probes until all sanding and grinding activities are complete to protect them from accumulating dust and debris.
- C. Prior to ordering, measure actual pipe size and verify furnished material as installed in field and provide to vendor.
- D. Mount transmitter at eye level. Measure distance from probe to transmitter and order wire whip of sufficient length to reach. Install probe wire whip in conduit of sufficient size for connector to pass through.
- E. Provide installation kit (i.e., threadolet, nipple/standoff, pipe tee, isolation valve, etc) to Mechanical Contractor for installation. Kit will be specific to the application. Installation accessories which are not provided by the vendor will not be acceptable.

3.8. RELAYS

- A. Nipple-mount relays will be mounted at a location where pilot light is visible from floor.

3.9. VALVES, DAMPERS, AND ELECTRONIC ACTUATORS INSTALLATION

- A. Wire parallel actuators according to manufacturer's recommendations.

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B. Dampers and Damper Actuators

1. Install automatic dampers according to Specifications.
2. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation per manufacturer installation instructions.
3. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately the 5° open position, manually close the damper, and then tighten linkage.
4. Provide necessary mounting hardware and linkages for actuator installation.
5. Install damper motors on outside of duct in climate controlled areas, including mechanical rooms. Provide sufficient standoff/offset of damper actuator from ductwork to allow for insulation behind actuator.
6. Where clearance cannot be maintained, locations exposed to outdoor temperatures, or actuator is inside ductwork, provide 12 inch by 12 inch access door per specifications for any actuator inside of ductwork.

C. Control Valves and Valve Actuators

1. Provide sufficient standoff/offset of valve actuator from piping to allow for insulation of valve.
2. Provide control valves in accordance with application schedule.
3. PIC Valves
 - a. Where not provided from the factory, install pressure/temperature test ports (Pete's Plugs) for testing of pressure differential across the PIC valve.
 - b. For PIC valves with electronic flow metering, coordinate with mechanical contractor to ensure 5 pipe diameters of straight pipe entering valve.

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PART 4 - CONTROL VALVE APPLICATION SCHEDULE

CONTROL VALVE APPLICATION SCHEDULE					
HYDRONIC SYSTEMS	SERVICE	CONFIGURATION	PIPE SIZES	VALVE TYPE	
	HEATING COILS	2-WAY 2-POSITION	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BUTTERFLY
		2-WAY MODULATING	2-INCHES AND SMALLER	PI	BALL
			2 1/2-INCHES AND LARGER	PI	BALL / GLOBE
		3-WAY MODULATING	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BALL / GLOBE
	COOLING COILS	2-WAY 2-POSITION	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BUTTERFLY
		2-WAY MODULATING	2-INCHES AND SMALLER	PI	BALL
			2 1/2-INCHES AND LARGER	PI	BALL / GLOBE
		3-WAY MODULATING	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BALL / GLOBE
	EQUIPMENT BYPASS	2-WAY 2-POSITION	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BUTTERFLY
		3-WAY 2-POSITION	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BALL / GLOBE
		3-WAY MODULATING	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BALL / GLOBE
	HEAT EXCHANGERS	2-WAY MODULATING	2-INCHES AND SMALLER	PI	BALL
			2 1/2-INCHES AND LARGER	PI	BALL / GLOBE
	ISOLATION VALVES	2-WAY 2-POSITION	2-INCHES AND SMALLER	PD	BALL
			2 1/2-INCHES AND LARGER	PD	BUTTERFLY

NOTES:

1. COIL AND EQUIPMENT WITH PRESSURE DEPENDENT CONTROL VALVES REQUIRE BALANCING VALVES. REFER TO 232119.
2. COIL AND EQUIPMENT WITH PRESSURE INDEPENDENT CONTROL VALVES DO NOT REQUIRE BALANCING VALVES.
3. 3-WAY VALVES SHALL BE CONFIGURED FOR MIXING OR DIVERTING BASED ON INDICATED ORIENTATION.

END OF 23 90 10 BAS SENSORS AND DEVICES

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SECTION 260100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 26.
- B. All sections of Division 26 are interrelated. Where materials are required to complete work associated with equipment in a specific section, but the materials are not specified within that specific section, the requirements for those materials shall be as specified elsewhere in Division 26.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
 - 1. Submittals.
 - 2. Coordination drawings.
 - 3. Record documents.
 - 4. Maintenance manuals.
 - 5. Rough-ins.
 - 6. Electrical installations.
 - 7. Cutting and patching.
 - 8. Inspections
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 26 Section "Basic Electrical Materials and Methods," for materials and methods common to the remainder of Division 26.

1.3 SUBMITTALS

- A. General: Follow the procedures specified in Division 01 Section "Submittal Procedures".
- B. Specific Requirements to Electrical Product Data and Shop Drawing Submittals:
 - 1. Submit newly prepared information, drawn to scale where applicable. Do not reproduce Contract Documents or use Contract Document images in the preparation of submittals.
 - 2. Any deviations from Contract Documents shall be clearly noted and highlighted, encircled, or otherwise visually identified.
 - 3. Product Data and Shop Drawings are separate items and shall be submitted with separate submittal numbers. Where both Product Data and Shop Drawings are required by the same specification section (i.e. Fire alarm) both items shall be submitted for review at the same time. Product Data and Shop Drawings will be reviewed separately by Engineer, but Engineer reserves the right to withhold review until both items have been received.

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4. Submittal Documents Quality: Facsimile documents are prohibited. Submittals containing sheets copied from facsimile documents will be automatically Rejected and returned to Contractor without review. Also submittals containing poor quality copies will be automatically Rejected and returned to Contractor without review.
 5. Submittal Document Binding: Use report covers with 3-hole, dual-prong tang fasteners or slide fasteners. Velo- and comb bound documents are also acceptable. Use of 3-ring binders is prohibited and will be automatically rejected and returned to Contractor without review.
- C. Additional copies may be required by individual sections of these Specifications.
- D. Substitution of Equivalent Products: Where individual sections require submittal for substitution of manufacturers and products equivalent to those listed under Manufacturers paragraph, submittals shall be in accordance with that section. Engineer has final authority on equivalence and acceptance.
1. Submittal of Substitution Request Forms are permitted by Prime Bidders only. Substitution Request Forms submitted by a vendor, distributor, or sub-contractor will not be accepted or reviewed.

1.4 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.5 OPERATION & MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures" In addition to the requirements specified in Division 01, include the following information for equipment items:
1. Product data for all equipment installed during construction. Product data shall be manufacturer literature, cut-sheets, and/or catalogs and shall clearly depict manufacturer and model number along with standard features and optional features where applicable.
 2. Where available for installed equipment, Contractor shall include manufacturer's published Installation and/or Owner's manuals.
 3. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 4. Programming report/summary for all systems with conditional logic programming (i.e. fire alarm, lighting control system, and PLCs)
 5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

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6. Warranty Information: Copies of documentation for all additional and secondary warranties shall be included.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 26 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

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10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 11. Install access panel or doors where units are concealed behind finished surfaces.
 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- B. Basis of Design: Where specific systems and products are shown or specified with a Basis of Design, the supporting work and appurtenances are shown and specified uniquely for the Basis of Design. Where systems and products other than the Basis of Design are installed, Contractor shall adjust circuiting, raceway infrastructure, cable type, wire size, supporting means, backbox type, and any other appurtenance as required for a complete, fully functional and operational system or product.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the following requirements:
1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Remove and replace defective Work.
 - b. Remove and replace Work not conforming to requirements of the Contract Documents.
 - c. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.
 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
 3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 4. Protection of Installed Work: During cutting and patching operations, protect adjacent installations. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 INSPECTIONS

- A. Authority Having Jurisdiction: Notify and schedule all inspections, with a minimum 10 day notice in writing prior, to the Authority Having Jurisdiction.

END OF SECTION 260100

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SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings 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. Electrical Equipment Installation.
 - 2. Sleeves and sleeve seals for raceway and cable.
 - 3. Firestopping.
 - 4. Cutting and patching for electrical construction.
 - 5. Touchup painting.

1.3 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.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in rooms.
- C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

PART 2 - PRODUCTS

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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. 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 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations. Provide any additional supporting means not provided by manufacturer to install equipment.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, or cable trays, 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.

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- 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. Sleeves for power raceway and cables: Steel, cut sleeves to length for mounting flush with both surfaces of walls.
- F. Sleeves for telecommunication cables: Rigid galvanized steel conduit, extend sleeves 2" on each side of wall. Provide plastic bushing on each end.
- G. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- H. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- I. 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.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. 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.

3.3 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.

3.4 FIRESTOPPING

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- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.6 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section "Interior Painting" and Division 09 Section "Exterior Painting"
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

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SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes 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. Field quality-control test reports: Submit all cable tests reports to Engineer ten days prior to Final Inspection.

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 NFPA 70.

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. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Southwire Company.
- B. Conductors: Comply with NEMA WC 70.

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- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Thomas & Betts Corporation.
 - 2. Ideal Industries, Inc.
 - 3. 3M; Electrical Products Division.
 - 4. Tyco Electronics Corp.
- B. Description: UL listed, factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Splices in solid conductors for branch circuits shall be made using Ideal Wirenuts, 3M Scotchlocks, or T&B Marrette pressure type wire connectors. Permanent crimp connectors are not acceptable.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Refer to feeder schedule on riser for location of copper feeders.
- B. Feeders: Aluminum compact stranded. Stranded for No. 1 AWG (100amp) and larger. Refer to feeder schedule on riser for location of aluminum feeders.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - 1. Where final connections to equipment are in flexible conduit, all conductors shall be stranded type.
- D. Minimum Size: No. 12 AWG for power and lighting circuits.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN or XHHW, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.

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- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.
 - 1. Concealed Lighting Branch Circuits: Type MC cable, #12 AWG, copper conductor, 90°C insulation. May be used for connecting light fixtures together. Maximum length is 15'. All home runs to first light fixture and switch legs shall be in conduit. Do not use for receptacle or other power circuits.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.
- G. Class 1 Control Circuits: Type THHN-THWN or XHHW, in raceway.
- H. Class 2 Control Circuits: Type THHN-THWN or XHHW, single conductors in raceway.

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. Voltage Drop: Conductor size shall be increased to account for voltage drop as follows:
 - 1. Where the conductor length from the panel to the first outlet on a 277V circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.
 - 2. Where the conductor length from the panel to the first outlet on a 120V circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Increase an additional wire size for every additional 50' to first outlet.
- F. Dedicated Neutrals: Provide dedicated neutral for all single-pole branch circuits, unless otherwise noted on plans.
- G. Support cables according to Division 26 Section "Hangers and Supports."
- H. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

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3.4 CONNECTIONS

- A. Keep conductor splices to a minimum. No feeders shall be spliced. No splicing shall be made except within outlet or junction boxes, troughs, or gutters.
- 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.
 - 1. Splices shall be made using with pre-insulated spring/coil connectors (wire nuts), insulated barrel mechanical lugs, or box mounted insulated terminal strips.
 - 2. Push-in type, permanent crimp-on type, and split-bolt type are prohibited.
 - 3. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Testing Technician
 - 1. The testing technicians shall be trained in all the methods of correctly and safely conducting the required test. The technician shall have regular experience conducting the required tests and they must have the knowledge to determine the serviceability of a specific piece of equipment.
- C. Tests and Inspections: After installing conductors and cables and before electrical circuitry has been energized, test conductors for compliance with following requirements.
 - 1. Physical Inspection and Testing
 - a. Verify cable ratings and data correspond to drawings and specifications.
 - b. Verify electrical connections are made to provide the electrical system described in the drawings and specifications.
 - c. Confirm bolted electrical connections are provided with high impedance using one of the following means:
 - 1) Measure the resistance with a low-resistance ohmmeter. Bolted electrical connection resistances shall be compared to resistances measured on similar connections. Any similar resistance values that deviate more than 50 percent should be investigated.
 - 2) Inspect the bolted connection and verify that it is at the manufacturer's rated torque using a calibrated torque wrench.
 - d. A thermographic test of the service entrance conductors and distribution feeders. Conductor connection points shall be visible during the test. All equipment should be energized and loaded during test. Thermographic images of any connections that fail the test must be submitted with a description of the failure including the probable cause of the failure. A thermographic test shall be performed, but not limited to, the following areas.

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- 1) Service entrance conductors and feeders rated for 100A or more.
 - e. Inspect cable connectors to verify they are correctly installed.
 - f. Verify all cables are identified and arranged according to the drawings and specifications.
 - g. Verify that all cable jackets and insulation are in good condition and did not sustain damage during installation.
2. Electrical Inspection and Testing
 - a. For feeder current-carrying phase conductors and neutrals: test the insulation resistance with respect to ground for one minute. Cables rated for 300 volts shall be tested with 500 volts DC and cables rated for 600 volts shall be tested with 1000 volts DC. All insulation resistance data gathered shall comply with manufacturer's documentation; if documentation does not exist, comply with the values found in Table 100.1 in the ANSI/NETA ATS-2009.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Test Reports: Prepare a written report to record the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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. 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 (or Aluminum where indicated on plans) 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. Bonding Cable: stranded conductor sized per NEC 250 requirements.
 - 4. Bonding Conductor: stranded conductor sized per NEC 250 requirements.
 - 5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; sized per NEC 250 requirements.

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2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

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. The raceway shall not be relied on for ground continuity.

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.
- 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.
- C. Grounding Bushings and Jumpers: Boxes provided with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers lugged to box.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:

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1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- B. Testing Technician
 1. The testing technicians shall be trained in all the methods of correctly and safely conducting the required test. The technician shall have regular experience conducting the required tests and they must have the knowledge to determine the serviceability of a specific piece of equipment.
- C. Physical Inspection and Testing
 1. Inspect grounding system to verify that it complies with the requirements in the drawings and specifications, as well as, NFPA 70 *National Electric Code Article 250*.
 2. Inspect the physical and mechanical condition and verify that it complies with manufacturer's standards. All portions of the grounding system shall be free of corrosion.
 3. Confirm bolted electrical connections are provided with high impedance using one of the following means:
 - a. Measure the resistance with a low-resistance ohmmeter. Bolted electrical connection resistances shall be compared to resistances measured on similar connections. Any similar resistance values that deviate more than 50 percent should be investigated.
 - b. Inspect the bolted connection and verify that it is at the manufacturer's rated torque using a calibrated torque wrench.
 4. Verify that adequate anchorage is in place for the grounding system.
- D. Electrical Inspection and Testing
 1. Conduct tests for fall of potential as defined by ANSI/IEEE 81 on the grounding system.
 2. Determine the resistance to ground throughout grounding system including equipment frames, systems neutral, and equipment grounding bars. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform ground resistance in all of, but not limited to, the areas listed below:
 - a. Main electrical distribution ground bar: 15 ohms
 - b. Main telecommunications ground bar: 15 ohms
 - c. Secondary telecommunications ground bars: 15 ohms
 - d. Lightning protection path to ground: 5 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.
 1. Retest required to show compliance with above value.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Test Reports: Prepare a written report to record the following:

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1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 SUBMITTALS

- A. Product Data: For anchors, supports, and slotted channel/strut systems.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 COORDINATION

- A. Refer to structural drawing for detail on hanging equipment/conduit from pre-cast planks.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

PART 2 - PRODUCTS

2.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, two-hole conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps as described in NECA 1 and NECA 101.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type 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.
 - 2. Powder-Driven Threaded Studs: Heat-treated steel 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.
 - 3. Toggle Bolts: All steel springhead type.
 - 4. Hanger Rods: Threaded steel.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: Comply with MFMA-4, factory-fabricated components for field assembly; 16-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. Spring steel fasteners are not permitted for use where exposed.
 - 6. Support raceways installed on interior of exterior building walls a minimum of 1/4 inch from wall surface using "clamp-back" struts.
 - 7. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
 - 8. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - 9. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals. Spring steel fasteners are not permitted for use in vertical runs. Support individual vertical runs using two-hole straps. Support parallel runs of vertical raceway together on channel using bolted clamps.
- D. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

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- F. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

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3.2 TABLE I: SPACING FOR RACEWAY SUPPORTS

HORIZONTAL RUNS

Raceway Size (Inches)	No. of Conductors in Run	Location	RMC & IMC (1)	EMT (1)	OFR (1)
3/4	1 or 2	Flat ceiling or wall.	5	5	5
3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7	5
3/4	3 or more	Any location.	7	7	...
3/4-1	3 or more	Any location.			
1 & larger	1 or 2	Flat ceiling or wall.	6	6	...
1 & larger	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10	5
1 & larger	3 or more	Any location.	10	10	...
Any		Concealed.	10	10	...

VERTICAL RUNS

Raceway Size (Inches)	No. of Conductors in Run	Location	RMC & IMC (1,2)	EMT (1)	OFR (1)
3/4		Exposed.	7	7	...
1,1-1/4		Exposed.	8	8	...
1-1/2 and larger		Exposed.	10	10	...
Up to 2		Shaftway.	14	10	...
2-1/2		Shaftway.	16	10	...
3 & larger		Shaftway.	20	10	...
Any		Concealed.	10	10	5

NOTES:

- (1) Support spacing listed in feet. Maximum spacing of supports 10 feet.
- (2) Maximum spacings for IMC above apply to straight runs only.
Otherwise the maximums for EMT apply.

Abbreviations: EMT - Electrical metallic tubing.
IMC - Intermediate metallic conduit.
RMC - Rigid metallic conduit.
OFR- Optic Fiber Raceway

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes interior and exterior 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. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

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.

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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, but are not limited to, the following:
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. O-Z Gedney; a unit of General Signal.
 - 3. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT: ANSI C80.3.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Fittings for EMT: Plated-steel hexagonal compression type. Cast, pot metal, set-screw, or crimp type fittings are not acceptable.
 - a. Couplings shall be “concrete tight” where concealed in masonry.
 - b. Box connectors shall be insulated throat type.
- G. 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.
- H. Refer to section 3.1, B for raceway color requirements. Provide colored raceway as indicated.

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. Aruco Corporation.
 - 3. Lamson & Sessions; Carlon Electrical Products.
 - 4. 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.

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2.3 METAL WIREWAYS

- 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.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Austin Electrical Enclosures
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers:
 - 1. Indoors (dry location): NEMA 1, Hinged type.
 - 2. Exterior & wet/damp locations: NEMA 3R, gasketed type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 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. Hoffman.
 - 4. RACO; a Hubbell Company.
 - 5. Thomas & Betts Corporation.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. 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.

PART 3 - EXECUTION

3.1 RACEWAY AND BOX APPLICATIONS

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit.

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3. Underground Conduit & Duct:
 - a. Feeders: RNC, Type EPC-40-PVC, direct buried.
 - b. Branch Circuit: RNC, Type EPC-40-PVC, direct buried.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit, Not Subject to Physical Damage: EMT.
 2. Exposed Conduit, Subject to Physical Damage: Rigid steel conduit.
 - a. Exposed conduit routed vertically and horizontally below 8' above finished floor in mechanical, electrical, and telecom rooms is considered subject to physical damage.
 - b. Exposed conduit routed vertically up through floor slabs shall be considered subject to physical damage until it reaches 8' above finished floor or enters a box, cabinet, or enclosure.
 - c. Exposed conduit routed down vertically from above 8' which enters boxes, cabinets, or enclosures mounted 48" to top above finished floor or higher is not considered exposed and subject to physical damage and EMT may be used.
 3. Conduit Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Conduit Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 5. Conduit in Damp or Wet Locations: Rigid steel conduit.
 6. Raceway Color Coding: Apply color coding to concealed raceway in all spaces and exposed in non-finished areas.
 - a. HVAC Controls Raceway: EMT raceway containing HVAC controls wiring shall have a factory applied blue finish.
 - b. Rigid steel conduit used for the above systems shall be field painted to match corresponding EMT Finish.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
 8. Boxes exposed in finished spaces: Boxes shall have solid sides, without pre-punched knockouts.
- C. 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.

3.2 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size:
 1. Interior: 3/4-inch trade size.
 2. Exterior, below grade: 1-inch trade size.
- C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

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- D. 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.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Boxes Above Lay-in Ceilings or Access Doors: Install boxes no further than 36" above accessible ceiling/access door.
- G. Complete raceway installation before starting conductor installation.
- H. Support raceways as specified in Division 26 Section "Supporting Devices."
- I. Use temporary closures to prevent foreign matter from entering raceways.
- J. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- K. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- L. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- M. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- N. Raceways Installed in Load Bearing Masonry: Raceways installed in load bearing masonry shall be either rigid galvanized steel conduit or coated EMT specifically rated and listed for installation in concrete.
- O. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- P. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
 - 1. Where concentric, eccentric, or over-sized knock outs are encountered, a grounding-type insulated bushing shall be provided.
- R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align

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raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

- S. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- T. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-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 the boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- U. Stub-up Connections: Where underground raceways are required to turn up into equipment, cabinets, etc., the elbow and stub-up shall be rigid steel. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- V. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- W. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 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."

3.4 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.

END OF SECTION 260533

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of all electrical equipment and system components used in identification signs and labels. Schedule shall depict preliminary printouts of proposed equipment labels for review prior to order.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).
- B. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

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- C. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: 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 the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 CEILING TAGS

- A. Ceiling Tags: 0.030-inch thick and 3/4 to 7/8-inch diameter rigid vinyl, self-adhesive, white or clear plastic tags with pre-printed, minimum 1/8-inch tall block-letter black text indicating the equipment, valve or accessory tag and number designations.
- B. Ceiling grid markers shall be the color as indicated. Beside all colored grid markers, a printed label shall be used to specify what the color marker is locating. Labels shall be no more than 1-inch in height. Lettering shall be minimum 18-point font. Lettering shall be black on white tape.
 - 1. Neon Red Sticker: Electrical – Pull Box/Future/Disconnects, etc.
 - 2. Neon Green: CCTV Camera Drops
 - 3. Neon Orange: Wireless Access Points
 - 4. Red Sticker: Fire Alarm/Sprinklers/Life Safety

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.3 kg) minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.

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1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
 1. General 277/480V and 120/208V Equipment: Black label with white core.
 2. Emergency Generation & Distribution Equipment: Orange label with white core.
 3. Stand-by Distribution Equipment: Green label with white core.
 4. Fire Alarm Equipment: Red label with white core.
 5. Voice, Data & Video Systems: Blue label with white core.
 6. Security Systems: Burgundy label with white core.
- C. Ceiling Tag Installation
 1. Install ceiling tags on lay-in grid and access doors below equipment, boxes, camera drops, Wireless Access Points (WAPs), and Fire Alarm devices above finished ceilings. Center tags on grid members and doors.
- D. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- E. Self-Adhesive Identification Products: Clean surfaces before applying.
- F. Install painted identification according to manufacturer's written instructions and as follows:
 1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime surfaces using type of primer specified for surface.
 3. Apply one intermediate and one finish coat of enamel.
- G. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below. Banding of colored conduit is not required.
 1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas. Also provide color banding at outlet box stub-ups.
 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.

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- b. Telecom (Intercom, Data, Video) Systems: Blue.
 - c. Security (CCTV, Intrusion Detection) System: Black.
 - d. Emergency Systems: Orange.
 - e. Stand-by Systems: Green.
 - 4. Color code cover of raceway junction boxes following the colors listed above.
 - 5. Spare raceway for future use shall be identified as such and shall indicate where raceway originates and terminates on each end.
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification Labels on Outlet Boxes, Junction Boxes and Pull Boxes: Install labels externally.
- 1. Outlet boxes (receptacles and switches) and exposed junction boxes: Pressure-sensitive, self-adhesive plastic label on faceplate. Use clear label with black letters.
 - 2. Concealed junction and pull boxes: Neat handwritten label using permanent black marker.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
 - 4. Future Use Circuits: Circuits for future use shall be identified as such and list panel and circuit number of source.
- J. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
- 1. Color-code 208/120-V system as follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 - 2. Color-code 480/277-V system as follows:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 - e. Ground: Green.
 - 3. Factory apply color the entire length of all conductors, except the following field-applied, color-coding methods may be used instead for service conductors:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- K. Apply identification to conductors as follows:
- 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

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2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- L. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- M. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. Locate label on exterior of any enclosure. This includes power, lighting, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide three lines of text with 1/4-inch high lettering on 1-1/2-inch high label; where four lines of text are required, use labels 2 inches high. Use surface and core colors as listed in Part 2 above. Provide labels for all electrical equipment listed below. In general, all labels shall include riser diagram ID, amperage, voltage, number of phases/poles, and equipment served from (source). Provide additional information as listed below:
1. Switchboard: include bus amperage and mimic bus.
 2. Panelboards: MCB/MLO.
 3. Disconnect switches: equipment served by.
 - a. Provide label for all disconnects provide by Division 23, 24 or 26.
 4. Enclosed circuit breakers: equipment served by.
 - a. Provide label for all disconnects provide by Division 23, 24 or 26.
 5. Contactors & Relay Panels.
 6. Fire Alarm Control Panel and auxiliary power supplies and enclosures.

END OF SECTION 260553

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- C. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. 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.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Wiring Devices:
 - a. Hubbell, Inc.; Wiring Devices Div.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 STRAIGHT BLADE RECEPTACLES

- A. General Purpose Receptacles: TAMPER-RESISTANT Heavy-Duty grade, rated 20A minimum. Comply with UL498.
1. NEMA 5-20R (standard #WD1.101968).
 2. Arranged for back and side wiring.
 3. Grounding type. Separate single or double grounding terminals with screw lugs and a direct, green insulated conductor connector to system ground. Screw shall be green and hex-headed. Self-grounding type are not acceptable.
 4. Tamper Resistant
 5. Listed by an approved third party agency.
- B. GFCI Receptacles: TAMPER RESISTANT Non feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter. Comply with UL 498 and UL 943, Class A. GFCI receptacles that are installed on the building exterior shall be weather resistant.

2.3 SWITCHES

- A. General Purpose Snap Switches: Heavy-duty, quiet type. Comply with NEMA WD1 and UL 20.
1. 20A, 120/277v, AC only.
 2. Grounding type, with green hex-head grounding screw.
 3. Quiet type operating mechanism; shall not utilize mercury switches.
 4. Listed by an approved third party agency.
- B. Equipment Disconnect Snap Switches: Heavy-duty, quiet type. Comply with NEMA WD1 and UL 20.
1. 30A, 120/277v, AC only.
 2. Grounding type, with green hex-head grounding screw.
 3. Quiet type operating mechanism; shall not utilize mercury switches.
 4. Listed by an approved third party agency.

2.4 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.

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1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.04-inch (1-mm) thick, Type 302, satin-finished stainless steel.
3. Material for Unfinished Spaces:
 - a. Flush Boxes: Same as finished spaces.
 - b. Surface-mount boxes: Galvanized steel with crushed corners, sized for wiring device installed. Mud-ringstyle, raised covers not allowed where boxes are exposed. Stacked covers or protruding edges are not allowed.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

- B. Wet-Location, Weatherproof Cover Plates: "In Use" cast aluminum with cover capable of closing with plug assembly still engaged, and listed and labeled for use in "wet locations."

2.5 FINISHES

- A. Color:
1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Receptacle Devices Connected to Stand-by Power System: Green, unless otherwise indicated or required by NFPA 70 or device listing.

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 insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:

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- a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (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. Mount vertically except where installed over counters, back-splashes, etc. mount horizontally.
 - 2. 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.
 - a. Provide 2% quantity of spare cover plates of each type to Owner.
- 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.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

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3.4 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches and controllers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

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 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 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 six of each size and type.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Feeders: Class RK1, UL listed, current limiting, 200kA interrupting rating.
- B. Motor and Motor Controller Branch Circuits: Class RK5, UL listed, current limiting time delay, 200 kA interrupting rating.
- C. Other Individual Equipment Branch Circuits: Class RK5, UL listed, non-time delay, 50 kA interrupting rating.

3.3 INSTALLATION

- A. Fuses shall be selected as to provide a fully selective system.

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- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Feeder and branch-circuit protection.
 - 2. Motor and equipment disconnecting means.

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.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
- 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.

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- D. 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.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, 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 NFPA 70.

1.6 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.

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. Fusible and Non-Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - 2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.

2.2 ENCLOSED SWITCHES

- A. All Switches:
 - 1. Heavy Duty type with nontearable, positive, quick make-quick break mechanisms.
 - 2. Handles whose positions are easily recognizable and are padlockable in either the "on" or "off" positions.

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3. Defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position.
- B. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- C. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks.
 1. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with full interrupting capacity to meet available fault currents.
 1. Electronic Trip Circuit Breakers: Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip and individually field-adjustable long time, short time, and instantaneous trip pickup level settings. Trip unit shall also have adjustable long time and short time delay settings. Provide for circuit-breaker frame sizes 250A and larger.
 2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Field adjustable instantaneous trip setting for circuit-breaker frame sizes 100 A to 225A.
 3. Breakers Serving Elevator Controllers: Field adjustable instantaneous-trip setting for circuit-breaker.
- B. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical 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. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 6. 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.

2.4 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 4X.
 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

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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. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
- B. Testing Technician
 - 1. The testing technicians shall be trained in all the methods of correctly and safely conducting the required test. The technician shall have regular experience conducting the required tests and they must have the knowledge to determine the serviceability of a specific piece of equipment.
- C. Physical Inspection and Testing
 - 1. Verify equipment rating correspond to drawings and specifications.
 - 2. Inspect the physical and mechanical condition and verify that it complies with manufacturer's standards.
 - 3. Verify equipment is properly secured and aligned as specified in the drawings and specifications.
 - 4. Verify the equipment is clean.
 - 5. Open and close circuit breaker to verify smooth and proper operation.
 - 6. Confirm bolted electrical connections are low impedance using one of the following means:

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- a. Measure the resistance with a low-resistance ohmmeter. Bolted electrical connection resistances shall be compared to resistances measured on similar connections. Any similar resistance values that deviate more than 50 percent should be investigated.
 - b. Inspect the bolted connection and verify that it is at the manufacturer's rated torque using a calibrated torque wrench. If manufacturer's data is not available verify the torque meets the requirements of Table 100.12 in the ANSI/NETA ATS-2009.
- D. Electrical Inspection and Testing
 1. Test the insulation resistance on each pole. The resistance should be measured from phase to phase and phase to ground while the breaker is engaged. When the switch is not engaged the insulation resistance should be measured across each pole. For testing purposes apply a voltage as recommended by the manufacturer. If no recommendations are available from the manufacturer refer to Table 100.1 in the ANSI/NETA ATS-2009.
- E. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Remove and replace units that do not pass tests and inspections and retest as specified above.
- H. Test Reports: Prepare a written report to record the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 262816