



## Trask Coliseum AHU-4 Replacement

STATE ID#: 20-22523-01A

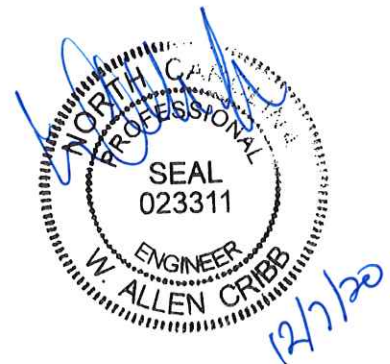
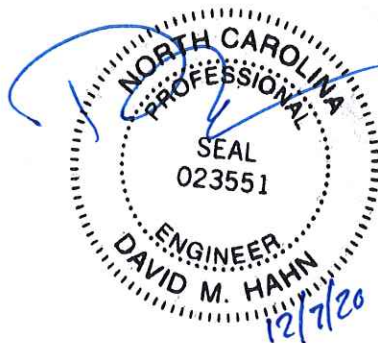
UNCW PM #: **5687**

### SPECIAL PROJECT Informal Contract

THE UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

PROJECT MANAGEMENT  
601 SOUTH COLLEGE ROAD,  
FACILITIES ADMINISTRATION BUILDING, ROOM 157  
WILMINGTON, N.C. 28403

DESIGNER: **CBHF Engineers**  
PROJECT MANAGER: **Robert Williams**  
PHONE: **(910) 962-7229**  
MOBILE PHONE: **(910) 622-5247**  
FAX: **(910) 962-7522**  
EMAIL: **williamsrh@uncw.edu**



SET NUMBER:



PREBID DATE: **December 8, 2020** Bid Date: **December 17, 2020**

## TABLE OF CONTENTS

<u>BIDDING AND CONTRACT DOCUMENTS</u>	<u>PAGE(S)</u>
NOTICE TO BIDDERS	NTB-1
INSTRUCTIONS TO BIDDERS	ITB-1 thru ITB-5
GENERAL CONDITIONS	GC-1 thru GC-11
SUPPLEMENTARY GENERAL CONDITIONS	SGC-1 thru SGC-5
FORM OF PROPOSAL	FOP-1 thru FOP-6
MINORITY BUSINESS CONTRACT PROVISIONS	HUB-1
IDENTIFICATION OF HUB PARTICIPATION	HUB-2
MBE DOCUMENTATION FOR CONTRACT PAYMENTS	Affidavits A, B, C, D, and E
SPECIFICATIONS –	
230000	GENERAL MECHANICAL
230010	EXISTING CONDITIONS
230020	MECHANICAL DEMOLITION
230519	METERS AND GAGES FOR HVAC PIPING
230523.12	BALL VALVES FOR HVAC PIPING
230523.13	BUTTERFLY VALVES FOR HVAC PIPING
230523.14	CHECK VALVES FOR HVAC PIPING
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230719	HVAC PIPING INSULATION
230900	BUILDING MANAGEMENT SYSTEM
232113	HYDRONIC PIPING
232116	HYDRONIC PIPING SPECIALTIES
232123	HYDRONIC PUMPS
233113	METAL DUCTS
233300	AIR DUCT ACCESSORIES
233723	HVAC GRAVITY VENTILATORS
237313.16	INDOOR, SEMI-CUSTOM AIR HANDLING UNITS
260500	GENERAL ELECTRICAL
260519	BUILDING WIRE & CABLE
260526	GROUNDING AND BONDING
260529	SUPPORTING DEVICES
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260534	BOXES
260553	ELECTRICAL IDENTIFICATION
260580	EQUIPMENT WIRING SYSTEMS
262813	FUSES

262816            ENCLOSED SWITCHES

DRAWINGS – DESCRIPTION OF DRAWINGS AS APPROPRIATE

G-001	COVER AND DRAWING INDEX
M-001	MECHANICAL LEGENDS, ABBREVIATIONS, GENERAL AND DEMOLITION NOTES
MD101	MECHANICAL THIRD FLOOR PLAN HVAC - DEMOLITION
MD102	MECHANICAL THIRD FLOOR PLAN HYDRONIC PIPING - DEMOLITION
MD103	MECHANICAL ROOF PLAN - DEMOLITION
MH101	MECHANICAL THIRD FLOOR PLAN HVAC
MH102	MECHANICAL ROOF PLAN HVAC
MP101	MECHANICAL PARTIAL FIRST FLOOR PLAN PIPING
MP102	MECHANICAL PARTIAL FIRST FLOOR PLAN PIPING
MP103	MECHANICAL THIRD FLOOR PLAN PIPING
MP401	MECHANICAL ENLARGED PLAN PIPING
M-501	MECHANICAL DETAILS
M-502	MECHANICAL DETAILS
M-601	MECHANICAL SCHEDULES
M-602	MECHANICAL CONTROL DIAGRAM, SEQUENCE OF OPERATIONS AND POINTS LIST
E-001	ELECTRICAL LEGEND, NOTES AND ABBREVIATIONS
ED101	ELECTRICAL THIRD FLOOR PLAN POWER - DEMOLITION
E-101	ELECTRICAL THIRD FLOOR PLAN POWER
E-501	ELECTRICAL DETAILS

END OF TABLE OF CONTENTS

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**NOTICE TO BIDDERS**

The State of North Carolina through the University of North Carolina at Wilmington requests proposals for the Special Project described below.

Sealed proposals will be received by the University of North Carolina at Wilmington ("Owner" or "University" or "UNCW") in Wilmington, North Carolina, **Project Management Department, in the Facilities Administration Building, Conference Room #1, up to 2:00 PM on Thursday December 17, 2020** and immediately thereafter publicly opened and read for the furnishing of labor, material and equipment entering into the construction of **TRASK COLISEUM – AHU-4 REPLACEMENT**. **Contractors may attend in person or by ZOOM Meeting Initiation.**

Bids will be received for "single prime contract" by Contractors with appropriate license(s) and/or registration. All proposals shall be lump sum.

Complete plans, specifications and contract documents will be made available at the Pre-bid Conference to be held on **Tuesday, December 8, 2020, 10:00 AM** in the UNCW Project Management Department, in the Facilities Administration Building, Room 157.

The UNCW Facilities Project # **5687** shall be clearly indicated on the outside of the envelope.

All contractors are hereby notified that they must have proper license and/or registration as required under the state laws governing their respective trades associated within this project.

**NOTE:** The bidder shall identify on its bid proposal the minority business participation it will use on the project and its good faith efforts in that regard. Forms are included within the Proposal Form in the bid documents. Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2(c))

General contractors are notified that Chapter 87, Article 1, General Statutes of North Carolina, will be observed in receiving and awarding general contracts.

Plumbing and heating contractors are notified that Chapter 87, Article 2, General Statutes of North Carolina, will be observed in receiving and awarding plumbing and heating contracts.

Electrical contractors are notified that provisions of Chapter 87, Article 4, General Statutes of North Carolina, will be observed in receiving and awarding electrical contracts.

Payment will be made in accordance with section "Requests for Payment" of General Conditions.

No proposal may be withdrawn after the scheduled time for opening of bids for a period of 30 days, except at the discretion of the Owner or as provided by General Statute G.S. 143-129.1.

The owner reserves the right to reject any or all bids and to waive informalities.

# UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

## INSTRUCTIONS TO BIDDERS

Proposals must be in accordance with the following instructions, requirements and procedures to be eligible for consideration:

### 1. LICENSE

All bidders are hereby notified that they must be in possession of a current and proper North Carolina Contractor License according to applicable state and local laws at the time of the bid submittal. Bidders are further notified that applicable provisions of Chapter 87, Article 1, North Carolina General Statutes, shall be observed in receiving bids and awarding contracts.

### 2. SINGLE CONTRACT PROPOSALS

Proposals for the project work shall be submitted under a single general contract proposal for the work described in the Scope of Work. Proposals shall be received under provisions of North Carolina General Statutes, Section 143-131, Informal Bid Proposals.

### 3. EXAMINATION OF PLANS, SPECIFICATIONS, AND SITE OF WORK

- A. Each bidder shall carefully examine the site of the proposed work, the Form of Proposal, the plans, specifications and any special provisions of the contract documents before submitting a bid. The submittal of a bid shall be considered full evidence that the bidder has made such necessary examinations, that they know and understand the conditions relating to the performance of the work required by the contract documents, and that the bidder has made every provision to operate under existing and stipulated conditions and has included all necessary items for the proper execution of work required by the contract documents.
- B. Inspection of the project site shall only be made during normal business hours and only by appointment with the Project Manager. Bidders shall not disrupt Owner operations during the course of such inspections. The University is an extremely active environment and visiting bidders shall comply fully with safety policies and the instructions of safety officials.

C. Contact:                      Project Manager: **Bob Williams**                      Phone: 910-962-7229

### 4. UTILITY CHARGES

While service or connection charges, or fees by serving utility companies, are not anticipated in connection with this project, any expenses relating to utility work during the execution of this project are the responsibility of the Contractor. Coordination and scheduling of any utility work to be performed by serving utilities, if required for relocation or temporary disconnection, shall be done with the advance approval of University and be the responsibility of the Contractor.

### 5. CLARIFICATIONS AND INTERPRETATION OF DOCUMENTS

Should any bidder be in doubt about the precise meaning or intent of any part of the plans, specifications or other contract documents, or find discrepancies or omissions therein, they shall immediately notify the Owner in writing and request a clarification. The Owner shall issue a clarification or correction by written addendum to all known bidders and to the office where bid documents are exhibited for inspection. The bidder in the spaces provided on the Form of Proposal shall acknowledge receipt of such addenda.

- *The Owner shall not be responsible for any oral instructions.*

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**INSTRUCTIONS TO BIDDERS**

6. PROPOSAL FORMS/ PREPARATION OF PROPOSALS

- A. Proposals shall be made in strict accordance with the Form of Proposal bound in these documents and shall be submitted on the supplied form.
- B. Bids shall be submitted on an exact copy of the Form of Proposal. Fill in all appropriate blank spaces provided for amounts, contract time, alternates, unit prices and addenda as applicable. Failure to furnish any requested itemized prices may disqualify the proposal. State the total amount bid in figures and in narrative in the proper spaces on the proposal form.
- C. No lineation, erasures, adjustments or alterations shall be made to the printed Form of Proposal. In receiving the bids, the Owner will assume that no such alterations have been made. If any such modifications become apparent after acceptance of the bid, they shall not be binding upon the Owner.
- D. Changes in any entry shall be made by marking through the initial entry and by inserting the corrected entry adjacent thereto. An authorized representative of the bidder shall initial each such correction in ink.
- E. The bidder shall identify on its bid proposal the minority business participation it will use on the project and its good faith efforts in that regard. Three forms are included within the Proposal Form in the bid documents (see HUB-1 thru HUB-2 and Affidavits A and B). Failure to complete and submit this form is grounds for rejection of the bid. (GS143-128.2(c))

MANNER OF EXECUTION

7.

- A. If by Sole Proprietor, state by adding "Owner" after the name of the person executing the documents.
- B. If by a Partnership, state by adding "Partner" after the name of the person executing the documents.
- C. If by a Corporation, indicate if by the President or by Vice-President and attest by the Secretary. Identify the title of office of the executing entities and impress the corporate seal on each signature page of the documents.
- D. If the proposal is made by a Joint Venture, each member of the Joint Venture shall execute the document in the above format for Sole Owner, Partner or Corporation, as applicable.
- E. If the Contractor License is held by a person other than an Owner, Partner or Officer of the Firm, then the Licensee shall also sign and be a party to the proposal. The title "Licensee" shall be indicated under such signature.

All signatures shall be properly witnessed and sealed.

8. SUBMITTAL OF PROPOSALS

- A. Enclose bid documents in an opaque, sealed envelope of sufficient size to accommodate the unfolded Bid documents. Identify the envelope in the upper left-hand corner as follows:

PROPOSAL FOR: UNCW SPECIAL PROJECT PM 5687

TRASK COLISEUM – AHU-4 REPLACEMENT

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

Name of Bidder: \_\_\_\_\_

Address: \_\_\_\_\_

Bidder License No. \_\_\_\_\_ Bidder Phone No. \_\_\_\_\_

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**INSTRUCTIONS TO BIDDERS**

- B. Address proposals to:

The Project Management Department  
The University of North Carolina at Wilmington  
601 South College Road  
Wilmington NC 28403-5620

- C. Proposals can be received as follows:

- a. Submit Bid prior to the bid opening date and time at the following location:

Director of Project Management Department  
Facilities Administration Building, Room 157  
601 South College Road  
The University of North Carolina at Wilmington  
Wilmington NC 28403-5620

- b. Submit Bid by delivery at or immediately prior to the bid opening date and time at the following location (late arrivals will not be accepted):

**Facilities Administration Building, Conference Room # 1**  
601 South College Road  
The University of North Carolina at Wilmington  
Wilmington NC 28403-5620

- D. Label the envelope on both sides **"SEALED BID ENCLOSED- DO NOT OPEN!"**

- E. Deliver or mail proposals to the Director of Project Management Department at the address specified above such that they are received by the University's Project Management Department before the stated time for bid opening as specified in the Notice to Bidders.

9. **MODIFICATION/WITHDRAWAL OF BID PROPOSAL**

- A. Submitted bids may be withdrawn or modified only by written request authorized by the bidder and delivered to the specified address for submittal of bids before the time established for bid opening.

- B. Modifications shall be made as follows:

Changes in any entry shall be made by marking through the initial entry and by inserting the corrected entry adjacent thereto. An authorized representative of the bidder shall initial and date each such correction in ink.

No proposal may be withdrawn after the scheduled time for opening of bids for a period of 72 hours, except at the discretion of the Owner or as provided by General Statute G.S. 143-129.1.

- C. Negligence, omissions or errors on the part of the bidder in preparing his bid shall not entitle them to withdraw or modify their bid after bids have been opened, except as provided by State Statutes, G.S. 143-129.1.
- D. Should the successful bidder fail to execute an agreement, the contract may be offered to the responsible bidder submitting the next lowest bid proposal, at the discretion of the Owner.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**INSTRUCTIONS TO BIDDERS**

10. **RECEIPT/OPENING OF PROPOSALS**

At the time and place established for the receipt of bids in the Notice to Bidders, every proposal for the specified work received by the Owner within the time specified shall be opened, acknowledged and read, regardless of any irregularities therein. Applicable North Carolina General Statutes shall be observed in receiving, opening and evaluating bids, and awarding contracts, if award is made.

- *The Owner reserves the right to reject any or all proposals and to waive informalities.*

11. **AWARD OF CONTRACT**

If the Owner elects to award a contract on the basis of bids received, the contract will be awarded to the responsible bidder submitting the lowest proposal, taking into consideration standards of quality, performance and the contract time specified in the proposal documents and agreement to the contract's General Conditions, Special Conditions, and Terms & Conditions. The award shall be made as soon as practicable after the receipt of proposals as provided elsewhere in these instructions.

12. **BIDDER QUALIFICATION**

- A. Before awarding a contract, the Owner reserves the right to require the apparent low bidder to qualify as a responsible bidder by furnishing such additional relevant information as necessary, which may include but is not limited to any of the following:
- a. Permanent name, address and telephone number of place of business.
  - b. Present name and trade, and the number of regular employees with proper qualifications for the required work.
  - c. Financial statement indicating assets and liabilities of the organization, current to within thirty days of the date of bid receipt or other financial information satisfactory to the Owner.
  - d. Proof of satisfactory performance of projects of similar scope or requiring specialized skills, experience and workmanship standards required for the work specified.
  - e. List of names and license numbers of organization members or employees who hold trade or professional licenses or credentials.
  - f. The name and home office address of the proposed Surety and identification of its authorized agent licensed in North Carolina.
  - g. List of principal materials and identification of suppliers and sub-contractors entering into the proposed contract work. Such list shall be subject to approval or rejection by the Owner in accordance with provisions of General and Supplementary General Conditions of the Contract.
- B. Any other information the Owner may deem relevant as bidder qualifications for the performance of the work required by the terms of the contract documents.
- C. Should the Owner adjudge that the apparent low bidder is not the lowest responsible bidder by virtue of the above qualifications that bidder will be so notified.



**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**INSTRUCTIONS TO BIDDERS**

13. NOTIFICATION OF AWARD: The Owner will notify the successful bidder, in writing, that their bid has been accepted and that the Owner intends to award them the contract, which shall constitute the Notice to Proceed. If an award is made, it will be made via the issuance of a Purchase Contract by UNCW Purchasing Services. The Owner reserves the right to extend its decision to award the contract from the successful bidder for such reasonable time beyond the stated forty-five (45) days.

END OF INSTRUCTIONS TO BIDDERS

# UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

## GENERAL CONDITIONS

### I. GENERAL

It is understood and agreed that by submitting a bid that the Contractor has examined these contract documents, drawings, and specifications, has visited the site of the Work, and has satisfied itself relative to the work to be performed.

### II. DEFINITIONS

Contractor: "Contractor" shall mean the entity that will provide the services for the Owner.

Contract Documents: "Contract Documents" shall consist of the Notice to Bidders; Instruction to Bidders; General Conditions; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the Form of Proposal; the Special Project Minority Participation Form; MBE Documentation for Contract Payments; the terms and conditions contained at <http://www.uncw.edu/Purchasing/documents/POTandCs.pdf>; Purchase Order(s) issued by the Owner; and insurance certificates. All of these items together form the contract. Any and all additional or modified terms and/or conditions included in any vendor document ("Additional or Modified Terms") constitute attempted material alterations of the Contract Documents. Any such Additional or Modified Terms shall be void unless expressly accepted in writing by the Owner.

Designer: The **designer(s)** are those referred to within this contract, or their authorized representatives. The Designer(s), as referred herein, shall mean architect and/or engineer responsible for preparing the project plans and specifications. They will be referred to hereinafter as if each were of the singular number, masculine gender. Designer-work may be done in-house by Owner.

Owner: "Owner" shall mean the University of North Carolina at Wilmington.

### III. SUBMITTAL DATA

The Contractor awarded the contract shall submit all specified submittals to the Owner/Designer. A minimum number of copies as specified by the owner, of all required submittal data pertaining to construction, performance and general dimensional criteria of the components listed in the technical specifications shall be submitted. No material or equipment shall be ordered or installed prior to written approval of the submittals by the Designer/Owner. Failure to provide submittal data for review on equipment listed in the technical specifications will result in removal of equipment by the Contractor at his expense if the equipment is not in compliance with the specifications.

### IV. SUBSTITUTIONS

In accordance with the provisions of G.S. §133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until five (5) days prior to the receipt of bids or by the date specified in the pre bid conference, when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

Submittals for proposed substitutions shall include the following information:

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

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

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

**V. MATERIALS, EQUIPMENT AND EMPLOYEES**

The Contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, fuel, sanitary facilities and incidentals necessary for the completion of his work, and shall install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same, and shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto as shown on the plans, stated in the specifications, or reasonably implied there from, all in accordance with the contract documents.

All materials shall be new and of a quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.

Upon notice, the Contractor shall furnish evidence as to quality of materials.

No changes shall be made in the Work except upon written approval and change order of the Owner. Change orders shall be subject to provisions in the current North Carolina Construction Manual.

Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the Contractor may select any product meeting this standard, by any manufacturer. When several products or manufactures are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the Contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufactures or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Request for substitution of materials, items, or equipment shall be submitted to the designer for approval or disapproval; the Designer prior to the opening of bids shall make such approval or disapproval. Alternate materials may be requested after the award if it can clearly be demonstrated that it is an added benefit to the owner and the Designer and Owner approves.

The Designer is the judge of equality for proposed substitution of products, materials or equipment.

If at any time during the construction and completion of the work covered by these contract documents, the language, conduct, or attire of any workman of the various crafts be adjudged a nuisance to the owner or designer, or if any workman be considered detrimental to the work, the contractor shall order such parties removed immediately from grounds.

The Contractor shall cooperate with the designer and the owner in coordinating construction activities.

The Contractor shall maintain qualified personnel and effective supervision at the site at all times during the project, and exercise the appropriate quality control program to ensure compliance with the project drawings and specifications. The Designer is responsible for determining compliance with the drawings and specifications.

The Contractor shall designate a foreman/superintendent who shall direct the work. The foreman /superintendent shall have a work cell phone and supply the number to the project manager.

The Contractor shall be responsible for the procurement, shipment, delivery, unloading, acceptance, storage, security and protection of all materials and equipment required to accomplish the project including all items provided by the Owner.

**VI. CODES, PERMITS AND INSPECTIONS**

The Contractor shall obtain the required permits, give all notice and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the Contractor observes that the drawings and specification are at variance therewith, he shall promptly notify the Owner in writing. If the Contractor performs any work

## UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

### GENERAL CONDITIONS

knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the Owner, he shall bear all cost arising therefrom.

All work under this contract shall conform to the North Carolina State Building Code and other state and national codes as are applicable.

Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to county or municipal building codes and may\* not be subject to inspection by county or municipal authorities. The Contractor shall, however, cooperate with the county or municipal authorities by obtaining building permits, if applicable. Permits shall be obtained by the Contractor at no cost to the Owner. All fire alarm work shall be in accordance with the latest State

\*Inspection and certification of compliance by local authorities is necessary if an architect or engineer was not employed on the project, or if the plans and specifications were not approved and the construction inspected by the State Construction Office.

Construction Office (SCO) *Guidelines for Fire Alarm Installation* (NFPA72). Where the contract documents are in conflict with the SCO guidelines, the SCO guidelines shall govern. The Contractor shall be responsible for all the costs for the correction of the work where he installs it in conflict with the latest edition of the SCO *Guidelines for Fire Alarm Installation*.

#### VII. SAFETY REQUIREMENTS

All Contractors shall be jointly responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the Owner or Designer, and by laws or ordinances governing such conditions. They shall be responsible for any damage to the Owner's property or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. They shall be responsible for and pay for any damages caused to the Owner. All Contractors shall have access to the project at all times, except as indicated in the Supplemental General Conditions.

The Contractor shall provide cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building, whether set by him, or any of the subcontractors. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the Owner.

No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the Designer and Owner.

The Contractor shall protect all trees and shrubs designated to remain in the vicinity of the operations by building substantial boxes around it. He shall barricade all walks, roads, etc., as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.

The Contractor shall provide all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.

The Contractor shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by General Statutes of North Carolina 95 126 through 155.

In the event of emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the Contractor is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

threatened injury or damage. Any compensation claimed by the Contractor on account of such action shall be determined as provided for under Article 13(b).

Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the Contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

**VIII. TAXES**

Federal Excise Taxes do apply to materials entering into State work (Internal Revenue Code, Section 3442 (3)).

Federal Transportation Taxes do not apply to materials entering into State work (Internal Revenue Code, Section 3475 (b) as amended).

North Carolina Sales Taxes and Use Tax do apply to materials entering into State work, and such costs shall be included in the bid proposal and contract sum.

Local Option Sales and Use Taxes, as required by law, do apply to materials entering into State work as applicable, and such cost shall be included in the bid proposal and contract sum.

Accounting Procedure for Refund of County Sales & Use Tax:

Amount of County Sales and Use Tax paid per contractor's statements:

Contractors performing contracts for state agencies shall give the state agency (i.e. Owner) for whose project the property was purchased a signed statement containing the information listed in G.S. 105-164.14(e).

The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from Contractors, Owner may obtain a certified statement as of April 1, 1991 from the Contractor setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The Contractor should also be notified that the certified statement might be subject to audit.

In the event the Contractor(s) make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the Contractor's warehouse stock and the amount of county sales or use tax paid thereon by the Contractor.

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

Contractors are not to include any tax paid on supplies, tools and equipment that they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment, which actually become a part of or annexed to a building or structure.

**IX. EQUAL OPPORTUNITY**

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

The non-discrimination clause contained in Section 202, Federal Executive Order 11246, as amended by Executive Order 11375, relative to Equal Employment Opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the Secretary of Labor, are incorporated herein.

The Contractor(s) agree not to discriminate against any employees or applicants for employment because of physical or mental handicap in regard to any position for which the employees or applicant is qualified. The Contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all employment practices.

**X. MINORITY BUSINESS PARTICIPATION**

GS §143-128.2 establishes a ten percent (10%) goal for participation by minority business in total value of work for each State building project.

For construction contracts with a value of less than \$300,000, there is a responsibility to make a good faith effort to solicit minority bids and to attain the goal. The Contractor shall include with his bid a completed Identification of HUB Certified/Minority Business Participation form. Contractor shall submit completed MBE Documentation for Contract Payments form with final payment request.

**XI. INSURANCE**

The Contractor(s) shall not commence work until they have obtained all insurance required, and such insurance has been approved by the Owner, nor shall the Contractor allow any subcontractor to commence work on their subcontract until all similar insurance required of the subcontractor has been obtained.

The Contractor shall provide and maintain during the life of this contract Workmen's Compensation Insurance as required by law for all employees employed at the site of the project under his contract, with minimum limits of \$100,000.

The Contractor shall provide and maintain, until final acceptance, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the Contractor or by any subcontractor, or by anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury:	\$500,000 per occurrence
Property Damage:	\$100,000 per occurrence / \$300,000 aggregate

In lieu of limits listed above, a \$500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

The Contractor shall purchase and maintain property insurance until final acceptance, upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the Owner, the Contractor, the subcontractors and sub-subcontractors in the work and shall insure against the perils of fire, wind, rain, flood, extended coverage, and vandalism and malicious mischief. If the Owner is damaged by failure of the contractor to purchase or maintain such insurance, then the Contractor shall bear all reasonable costs properly attributable thereto; the Contractor shall affect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the Contractor.

The Contractor shall furnish such additional insurance as may be required by the Owner or by the General Statutes of North Carolina, including motor vehicle insurance in amounts not less than statutory limits.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

All policies shall be issued by insurance companies acceptable to Owner. All insurance policies shall contain an endorsement including Owner as an additional insured and shall be primary to any other insurance that may be available to Owner. Each Certificate of Insurance shall bear the provision that the policy cannot be canceled, reduced in amount or coverage eliminated in less than thirty (30) days after mailing written notice to the insured and/or the Owner of such alteration or cancellation, sent by registered mail. Contractor will provide Owner with current written certificates of such insurance for the life of this contract, including a copy of all additional insured endorsements, prior to issuance of the Notice to Proceed or commencement of the work.

The Contractor shall furnish the Owner with satisfactory proof of carriage of the insurance required before the Owner grants written approval.

**XII. REQUESTS FOR PAYMENT**

All requests for payment must be submitted to Facilities Administration at the address listed in item (F) below.

For all projects with a total contract price of *\$100,000.00 or above*, **ALL** requests for payment **MUST** be submitted on the "AIA APPLICATION FOR PAYMENT AND CERTIFICATE FOR PAYMENT" AIA DOCUMENT G702 and G703

For all projects with a total contract price *below \$100,000.00*, requests for payment may be submitted either on the "AIA APPLICATION FOR PAYMENT AND CERTIFICATE FOR PAYMENT" AIA DOCUMENT G702 and G703 or on company invoice.

All requests for payment must contain a completed form "MBE DOCUMENTATION FOR CONTRACT PAYMENTS" (p. MBE-1).

The Designer/Owner will process all Contractor pay requests as the project progresses. The Contractor shall receive payment within thirty (30) consecutive days after Designer/Owner's approval of each pay request. Payment will only be made for work performed as determined by the Designer/Owner.

**Retainage:**

- a. Retainage withheld will not exceed 5% at any time.
- b. The same terms apply to general contractor and subcontractors alike.
- c. Following 50% completion of the project no further retainage will be withheld if the contractor/subcontractor has performed their work satisfactorily.
- d. Exceptions:
  1. Owner/Contractor can reinstate retainage if the contractor/subcontractor does not continue to perform satisfactorily.
  2. Following 50% completion of the project, the owner is authorized to withhold additional retainage from a subsequent periodic payment if the amount of retainage withheld falls below 2.5%.

No partial payment will be made unless agreed to in advance. Final payment will be made lump sum within forty-five (45) consecutive days after acceptance of the work and the submission both of notarized contractor's affidavit and four copies of invoices which are to include the contract, account and job order numbers. All pay requests shall be submitted to the Designer/Owner for approval.

Upon completion of the project, a "Final" inspection will be performed jointly by the Owner, representatives of any required state or local agencies, and the Contractor for acceptance of the Contractor's work. At that time a punch list will be prepared and a copy provided to the Contractor. If applicable to the project, copies of all DOI inspection reports, O&M manuals, system training and testing are required before final payment can be issued. Upon completion of all work, including the punch list items, the project will be authorized for payment by the Owner.

**The Contractor's final affidavit shall state:**

**"This is to certify that all costs of materials, equipment, labor, and all else entering into the accomplishment of this contract, including payrolls, have been paid in full."**

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

Executed contract documents, insurance certifications and, upon completion and acceptance of the work, applications for payment, invoices and other information requested are to be sent to:

University of North Carolina at Wilmington  
Office of Facilities – 5910  
601 South College Road  
Wilmington, North Carolina 28403-5910

It is imperative that contract documents, invoices, etc., be sent only to the above address in order to assure proper and timely delivery and handling.

**XIII. ASSIGNMENT**

No assignment of the Contractor's obligations or the Contractor's right to receive payment hereunder shall be permitted. However, upon written request approved by the Owner and solely as a convenience to the Contractor, the Owner may: (1) forward the Contractor's payment check directly to any person or entity designated by the Contractor, and (2) include any person or entity designated by Contractor as a joint payee on the Contractor's payment check. In no event shall such approval and action obligate the Owner to anyone other than the Contractor, and the Contractor shall remain responsible for fulfillment of all contract obligations.

**XIV. ANNULMENT**

If the Contractor fails to begin the work under the contract within the time specified, or the progress of the work is not maintained on schedule, or the work is not completed within the time specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the Contractor shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the Owner may give notice in writing, sent by certified mail, return receipt requested, to the Contractor and his surety (if applicable) of such delay, neglect or default, specifying the same, and if the Contractor within a period of seven (7) days after such notice shall not proceed in accordance therewith, then the Owner shall, declare this Contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this Contract in the manner and within the time frame specified. In the event the contractor, or the surety (if applicable) shall fail to take over the work to be done under this Contract within seven (7) days after being so notified and notify the owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the Owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said Contractor, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said Contract according to the terms and provisions thereof or use such other methods as in his opinion shall be required for the completion of said Contract in an acceptable manner. All costs and charges incurred by the Owner, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due said Contractor and surety (if applicable). In case the expense so incurred by the Owner shall be less than the sum which would have been payable under the contract, if it had been completed by said Contractor, then the said Contractor and surety (if applicable) shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and the surety (if applicable) shall be liable and shall pay to the owner the amount of said excess.

**XV. TERMINATION FOR CONVENIENCE**

a. Owner may at any time and for any reason terminate Contractor's services and work at Owner's convenience, after notification to the contractor in writing via certified mail. Upon receipt of such notice, Contractor shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

b. Upon such termination, Contractor shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by Contractor as approved by Owner; (3) plus ten percent (10%) of the cost of the balance of the work to be completed for overhead and profit. There



**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

shall be deducted from such sums as provided in this subparagraph the amount of any payments made to Contractor prior to the date of the termination of this Agreement. Contractor shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

**XVI. CHANGES IN THE WORK AND CLAIMS FOR EXTRA COST**

a. The Owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the Contractor from any guarantee given by him pertinent to the Contract provisions. All extra work shall be executed under conditions of the original Contract.

b. Except in an emergency endangering life or property, no change shall be made by the Contractor except upon receipt of approved change order from the Designer, countersigned by the Owner authorizing such change. No claim for adjustments of the Contract price shall be valid unless this procedure is followed. Should a claim for extra compensation by the Contractor be denied by the Designer or the Owner, the contractor may pursue his claim in accordance with G.S. §143-135.3.

In the event of emergency endangering life or property, the Contractor may be directed to proceed on a time and material basis whereupon the Contractor shall proceed and keep accurately on such form as specified by the Designer or Owner, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work, the change order will be prepared as outlined under either Method "c (1)" or Method "c (2)" or both, as described below.

c. In determining the values of changes, either additive or deductive, Contractors are restricted to the use of the following methods:

1. Where the extra work involved is covered by unit prices quoted in the proposal, or subsequently agreed to by the Contractor, Designer, Owner and State Construction Office the value of the change shall be computed by application of unit prices based on quantities, estimated or actual as agreed of the items involved, except in such cases where a quantity exceeds the estimated quantity allowance in the Contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c (2) herein. If neither party elects to proceed under c (2), then unit prices shall apply.

2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the Contract price.

d. Under Paragraph "b" and Methods "c(2)" above, the allowances for overhead and profit combined shall be as follows: all contractors (the single contracting entity (prime), his subcontractors (1st tier subs), or their sub-subcontractors (2nd tier subs, 3rd tier subs, etc.) shall be allowed a maximum of 10% on work they each self-perform; the prime contractor shall be allowed a maximum of 5% on contracted work of his 1st tier sub; 1st tier, 2nd tier, 3rd tier, etc. contractors shall be allowed a maximum of 2.5% on the contracted work of their subs. ; Under Method "c(1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c (2)" and Paragraph (b) above, the Contractor shall include no less than five percent (5%) profit, but no allowances for overhead.

e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:

1. The actual costs of materials and supplies incorporated or consumed as part of the work;

2. The actual costs of labor expended on the project site; labor expended in coordination, change order negotiation, record document maintenance, shop drawing revision or other tasks necessary to the administration of the project are considered overhead whether they take place in an office or on the project site.

3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker's compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the work;

5. The actual costs of premiums for insurance, permit fees and sales or use taxes related to the work.

Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the Owner.

f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the Contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods. All change orders shall be supported by a unit cost breakdown showing method of arriving at net cost as defined above.

g. Change orders shall be submitted by the Contractor in writing to the Owner/Designer for review and approval. The Contractor will provide such proposal and supporting data in suitable format. The Designer shall verify correctness. Delay in the processing of the change order due to lack of proper submittal by the Contractor of all required supporting data shall not constitute grounds for a time extension or basis of a claim. Within fourteen (14) days after receipt of the Contractor's accepted proposal including all supporting documentation required by the Designer, the Designer shall prepare the change order and forward to the contractor for his signature or otherwise respond, in writing, to the Contractor's proposal. Within seven (7) days after receipt of the change order executed by the Contractor, the Designer shall, certify the change order by his signature, and forward the change order and all supporting data to the Owner for the Owner's signature. The Owner shall execute the change order, within seven (7) days of receipt.

h. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.

i. If, during the progress of the work, the Owner requests a change order and the Contractor's terms are unacceptable, the Owner, may require the Contractor to perform such work on a time and material basis whereupon the Contractor shall proceed and keep accurately on such form as specified by the Designer or Owner, a correct account of cost together with all proper invoices, payrolls and supporting data. Upon completion of the work a change order will be prepared with allowances for overhead and profit per paragraph d. above and "net cost" and "cost" per paragraph e. above. Without prejudice, nothing in this paragraph shall preclude the Owner from performing or to have performed that portion of the work requested in the change order.

**XVII. PAYMENTS WITHHELD**

The Designer with the approval of the Owner may withhold payment for the following reasons:

a. Faulty work not corrected.

b. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.

c. To provide for sufficient contract balance to cover liquidated damages that will be assessed.

d. The secretary of the Department of Administration may authorize the withholding of payment for the following reasons:

i. Claims filed against the Contractor or evidence that a claim will be filed.

ii. Evidence that subcontractors have not been paid.

When grounds for withholding payments have been removed, payment will be released. Delay of payment due the Contractor without cause will make owner liable for payment of interest to the contractor as provided in G.S. §143-134.1. As provided in G.S. §143-134.1(e), the owner shall not be liable for interest on payments withheld by the Owner for unsatisfactory job progress, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

**XVIII. PROJECT SITE CLEANING UP**

The Contractor shall keep the sites and surrounding area reasonable free from rubbish at all times and shall remove debris from the site from time to time or when directed to do so by the Owner. Before final inspection and acceptance of the project, the Contractor shall thoroughly clean the sites, and completely prepare the project and site for use by the Owner. The Contractor shall provide trash containers for removal of rubbish generated by the work. Contractors shall not use the university's refuse containers.

At the end of construction, the Contractor shall oversee and implement the restoration of the construction site to its original state. Restoration includes but not limited to walks, drives, lawns, trees and shrubs, corridors, stairs and other elements shall be repaired, cleaned or otherwise restored to their original state.

**XIX. GUARANTEE**

Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The Contractor shall replace such defective equipment or materials, without cost to the Owner, within the manufacturer's warranty period.

The Contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the final acceptance of the work and shall replace such defective materials or workmanship without cost to the Owner.

Contractor shall guarantee materials and workmanship against latent defects arising from faulty materials, faulty workmanship or negligence which is hidden or not readily apparent to the Owner at the time of final acceptance and which is discovered by the Owner within six (6) years following final acceptance of the work. The guarantee for latent defects related to any structural system shall be ten (10) years. The Contractor shall replace such defective materials or workmanship without cost to the Owner. Additionally, the Owner may bring an action for latent defects caused by the negligence of the Contractor, which is hidden or not readily apparent to the Owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

Guarantees for roofing workmanship and materials shall be stipulated in the specification sections governing such roof, equipment, materials, or supplies.

**XX. CONTRACTOR-SUBCONTRACTOR RELATIONSHIPS**

The Contractor agrees that the terms of these contract documents shall apply equally to a subcontractor as to the Contractor, and that the subcontractor is bound by those terms as an employee of the Contractor. Contractor agrees to take such action as may be necessary to bind each Subcontractor to these terms. The Contractor further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to Contractor-Subcontractor relationships. The Owner reserves the right to limit the number of portions of work to be subcontracted as hereinafter specified.

The Contractor is and remains fully responsible for his own acts or omissions as well as those of any subcontractor or of any employee of either. The Contractor agrees that no contractual relationship exists between the subcontractor and the Owner in regard to the contract, and that the subcontractor acts on this work as an agent or employee of the Contractor.

**XXI. ACCESS TO PERSONS AND RECORDS**

The State Auditor shall have access to persons and records as a result of all contracts or grants entered into by the Owner in accordance with General Statute §147-64.7. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for lost efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**GENERAL CONDITIONS**

through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

**XXII. OWNER'S RIGHT TO DO WORK**

If, during the progress of the work or during the period of guarantee, the Contractor fails to prosecute the work properly or to perform any provision of the contract, the Owner, after seven (7) days' written notice sent by certified mail, return receipt requested, to the Contractor from the Designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the Contractor, such action and cost of same having been first approved by the Designer. Should the cost of such action of the Owner exceed the amount due or to become due the contractor, then the Contractor or his surety, or both, shall be liable for and shall pay to the Owner the amount of said excess.

**XXIII. GOVERNING LAWS**

This Contract is made under and shall be governed by and construed in accordance with the laws of the State of North Carolina. The Contractor shall comply with all applicable federal, State and local laws, statutes, ordinances and regulations including, but not limited to, the Omnibus Transportation Act of 1991 and its implementing regulations.

**XXIV. CONTRACTOR EVALUATION**

The Contractor's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to bid on future State projects. In addition to final evaluation, an interim evaluation may be prepared during the progress of project. The Owner may request the Contractor's comments to evaluate the designer.

**END OF GENERAL CONDITIONS**

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**SUPPLEMENTARY GENERAL CONDITIONS**

**I. GENERAL**

The following supplements modify, expand certain portions of, or provide additional or more specific information or instructions to requirements of the General Conditions of the Informal Bid Contract, published by North Carolina Department of Administration, State Construction Office. In case of conflict or discrepancy, the more restrictive requirements shall govern except when specifically modified or rescinded by direct reference or instructions.

**II. DRAWINGS**

The bound set of Graphical Documents, identified in the following Schedule of Drawings, prepared specifically for the Project which includes:

Drawings:

G-001	COVER AND DRAWING INDEX
M-001	MECHANICAL LEGENDS, ABBREVIATIONS, GENERAL AND DEMOLITION NOTES
MD101	MECHANICAL THIRD FLOOR PLAN HVAC - DEMOLITION
MD102	MECHANICAL THIRD FLOOR PLAN HYDRONIC PIPING - DEMOLITION
MD103	MECHANICAL ROOF PLAN - DEMOLITION
MH101	MECHANICAL THIRD FLOOR PLAN HVAC
MH102	MECHANICAL ROOF PLAN HVAC
MP101	MECHANICAL PARTIAL FIRST FLOOR PLAN PIPING
MP102	MECHANICAL PARTIAL FIRST FLOOR PLAN PIPING
MP103	MECHANICAL THIRD FLOOR PLAN PIPING
MP401	MECHANICAL ENLARGED PLAN PIPING
M-501	MECHANICAL DETAILS
M-502	MECHANICAL DETAILS
M-601	MECHANICAL SCHEDULES
M-602	MECHANICAL CONTROL DIAGRAM, SEQUENCE OF OPERATIONS AND POINTS LIST
E-001	ELECTRICAL LEGEND, NOTES AND ABBREVIATIONS
ED101	ELECTRICAL THIRD FLOOR PLAN POWER - DEMOLITION
E-101	ELECTRICAL THIRD FLOOR PLAN POWER
E-501	ELECTRICAL DETAILS

The drawings and specifications are complementary, one to the other. That which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a complete job. In case of discrepancy or disagreement in the Contract Documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.

In such cases where the nature of the work requires clarification by the Designer/ Owner, the Designer/ Owner shall furnish such clarification. Clarifications and drawings shall be consistent with the intent of the Contract Documents, and shall become a part thereof.

Contractor shall provide one complete set of legible "as-built" marked-up construction drawings and specifications recording any and all changes made to the original design during the course of construction. In the event no changes occurred, submit construction drawings and specifications set with notation "No Changes." The Designer/Owner must receive "As-built" marked-up construction drawings and specifications before the final pay request can be processed.

## UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

### SUPPLEMENTARY GENERAL CONDITIONS

The contractor shall maintain, in readable condition at his job site one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the owner, designer or his authorized representative.

The contractor shall maintain at the job site, a day to day record of work in place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the contractor and submitted to the designer upon project completion and no later than 30 days after acceptance of the project.

#### III. SCHEDULE

The Contractor shall commence work as soon as possible after Notice to Proceed is issued or as specified in the contract documents. The time stated in the contract shall include all time necessary for final cleanup. The Contractor shall furnish the Owner a job schedule within five (5) working days of the contract award. Work performed in the execution of this contract shall be a continuous and uninterrupted progression of work unless specifically stated otherwise in the contract or approved in writing by the Owner. The schedule must be strictly adhered to. Contingency plans for having properly trained workers and supervision must be in place. Work may begin on an agreed-upon time and date with UNCW. Project must be complete and ready for use by an agreed-upon time and date with UNCW.

#### IV. EXISTING CONDITIONS

The Contractor, in submitting a proposal and executing a contract, acknowledges that he has completely investigated all existing facilities and job site conditions, including those of a subsurface nature, and clearly understands the intent and requirements of the contract documents. Failure to inspect the site or contract documents prior to bidding will not relieve the Contractor of the responsibility to perform all work included in this contract.

#### V. LICENSE REQUIRED

A current Contractor Board Registered Contractor License is required for this project. The Contractor License number shall be included on the "Execution of Bid" document where applicable.

#### VI. PRE-CONSTRUCTION CONFERENCE

There will be a Pre-Construction Conference for this project to be scheduled by the Project Manager with the successful bidder after "Notice to Proceed" has been issued.

#### VII. CONSTRUCTION STAKEOUT

The Contractor is responsible for locating the plantings on the drawings at the locations shown in the field. Any stakes, layout, and measurements required to perform the work described in the specifications and accompanying plans will be the responsibility of the Contractor.

#### VIII. COPIES OF DRAWINGS AND SPECIFICATIONS

The Owner shall furnish the Contractor free of charge copies of plans and specifications as follows:

- A. Contractor - Up to three (3) sets of the drawings described in the Schedule of Drawings and three (3) complete sets of the specifications.
- B. Other Contractors - No additional drawings and specifications shall be provided for the use of any other contractor.

#### IX. USE OF PREMISES

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**SUPPLEMENTARY GENERAL CONDITIONS**

A. SITE RESTRICTIONS - The Contractor shall ensure uninterrupted access and public safety in the area of the job site. The Contractor shall conduct his operations in strict compliance with regulations, policies and operating procedures established by the University.

B. SECURITY RESTRICTIONS - The Contractor shall follow directions set forth by the University Police and Safety Personnel.

X. CLAIMS FOR DELAYS OR ADDITIONAL COST

No claims for delays or additional costs by any Contractor shall be considered due to restrictions of operations or limitations of schedule or of hours of operation as required by the terms of the Contract.

XI. CUTTING, PATCHING AND DIGGING:

A. PREVENTING DAMAGE - The Contractor shall exercise every precaution to prevent damage or alteration of any existing material, detail, finish or other site feature scheduled to remain during the performance of the work. Any cost for additional patching and repair due to incorrect, excessive or careless cutting, demolition or other related damages as determined by the Owner, shall be paid by the Contractor.

B. OWNER'S AUTHORITY TO SUSPEND OPERATIONS - The Owner shall have authority to limit or suspend any operations which, in their opinion, may threaten the integrity of any existing structures, systems, finishes or details, or which compromise public health or safety. The Contractor shall comply immediately with any directive issued by the Owner, which relates to safety issues or the protection of existing features without the requirement for advance written notice.

C. DIGGING PROCEDURES - See Section 11-F of the Supplementary General Conditions for instructions relating to required digging procedures. All trenches, holes dug will be tamped back and sod grass of like kind placed in these areas. The level of the sod should match adjacent elevations. Contractor will correct any settling of these areas for a period of 12 months. A complex drain system exists on these fields. Contractor shall make all effort to not cut this system, but in the event of a cut will repair the drain system at no additional costs to the owner.

D. NCOSHA STANDARDS COMPLIANCE - The Contractor is responsible for following pertinent NCOSHA safety standards during the completion of this Contract, including compliance with regulation pertaining to any digging/trenching operations.

XII. UTILITIES

A. UTILITY CHARGES and CONNECTIONS - No service or connection charges or fees by serving utility companies are anticipated in connection with the Project Work. In the event such charges are levied by any serving utility, the Owner shall reimburse the Contractor for utility service and/or connection charges at direct invoice from the billing Utility Company, after certification of the invoice by the Owner.

B. COORDINATION AND SCHEDULING OF UTILITY WORK - Coordination and scheduling of work to be performed by serving utilities, if required for relocation or temporary disconnection, shall be the responsibility of the Contractor whose work requires such adjustments.

C. AVAILABILITY OF UTILITIES TO CONTRACTOR - The Owner shall make existing power and water for construction operations available to the Contractor. Contractor shall make connections to service junctures in compliance with applicable codes at his expense. The point of any utility connection shall be established by the Owner before the commencement of any connection activity. The Contractor shall restore all utilities to their original state prior to final inspection.

D. SPECIAL REQUIREMENTS - The existing Utilities Services (Power, Telephone, Water, Sanitary) and all connections and branch circuits shall be maintained in continuous operation during the course of the project construction except for required modifications. A minimum of a 48-hour advance written notice to

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**SUPPLEMENTARY GENERAL CONDITIONS**

the Owner from the Contractor shall be required prior to the commencement of any critical interruption that has been approved in writing by the Owner.

- E. UNDERGROUND UTILITIES - Buried telephone lines and cables, high voltage electrical power cables, water and gas mains, sanitary sewer mains and storm water drains may be encountered during excavation activities. The Contractor must anticipate this possibility and make every effort to avoid damage to underground utilities.
- F. DIGGING PROCEDURES
  - a. UNCW DIGGING PERMIT - A **UNCW Digging Permit** must be obtained from the University Physical Plant Division by the Contractor immediately after the Contract Award and prior to the commencement of any digging/trenching activity relating to the project.
  - b. NOTIFICATION - The Contractor shall notify the Owner three (3) days prior to any digging/trenching operations to schedule the locating and marking of existing underground utilities by the Owner. The Owner will attempt to determine exact utility locations within the three (3) day period. Under no circumstances shall any digging/trenching operations occur before the marking of buried utility locations by the Owner. Under no circumstance is any utility work, such as connections or disconnections, to be performed by the Contractor without a three (3) day prior notification to the Owner.
  - c. "NO CUTS" NOTIFICATION - The Contractor shall be responsible for contacting, arranging and coordinating the location of any additional buried utilities with "NO CUTS" utility location service.
  - d. RE-NOTIFICATION - Should weather or other site conditions render the utility location markings undistinguishable, it will be the Contractor's responsibility to re-contact the parties described above and have the utility location relocated and re-marked giving the same three (3) day prior notification to the Owner.
  - e. LOCATION OF UTILITIES – The Contractor shall locate all marked underground utilities by hand digging prior to the beginning of any digging/trenching operations.
  - f. REPAIR OR DAMAGE COST - The Contractor shall be responsible for any cost relating to the repair of damaged utilities caused by the Contractor or their agents.

**XIII. OWNER INSPECTIONS:**

- A. DURING CONSTRUCTION – The Owner reserves the right to provide full time or part time inspection during construction to verify that plans and specifications are being met as the work progresses. Poor or substandard workmanship will not be accepted by the Owner. The Owner shall resolve conflicts arising from interpretations of the plans and/or specifications and their decision shall be binding. If in the process of his inspection, work is determined to be of poor or substandard workmanship, or not in compliance with the drawings and/or specifications, the Owner reserves the right to stop all work at no additional cost until corrective action is taken by the Contractor to bring the work into compliance. Inspection by the Owner does not relieve the Contractor of their responsibility to meet the requirements of the plans and specification nor to provide any quality control that may be required. All changes to the contract shall be in writing.
- B. FINAL INSPECTION/PROJECT COMPLETION – Upon completion of the project, a "Final" inspection will be performed by the Owner and the Contractor's representative for acceptance of the Contractor's work. At that time, a punch list will be prepared and a copy provided to the Contractor. Upon completion of all work, including the punch list items, the project will be authorized for payment by the Owner.

**XIV. SAMPLES AND TESTING:**



**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**SUPPLEMENTARY GENERAL CONDITIONS**

- A. All material and aggregate samples shall be provided by the Contractor at his expense and shall be approved by the Owner prior to their use on the job. Additional samples of materials may be requested by the Owner during construction and shall be provided by the Contractor at no expense to the Owner.
- B. Tests to determine conformance with the specified requirements may be required by the Owner and will be performed by an independent testing laboratory, arranged and paid for by the Owner. If repeated tests are required due to the Contractor's failure to meet specifications, the Owner will arrange all subsequent tests of the same portion of work, with all associated cost being paid for by the Contractor.

**XV. SANITARY FACILITIES**

- A. Temporary sanitary convenience for the use of employees on the job site shall be provided and maintained in a timely manner by the Contractor and removed upon completion of the work. The Contractor is only to use conveniences approved by health authorities.
- B. Contractor employees are not permitted to use any existing sanitary facilities located on the University.

**XVI. ADDITIONAL CLEANING UP RESPONSIBILITIES**

- A. DAILY CLEANUP - The entire work site shall be placed in an orderly manner at the end of each workday, including the proper placement of any safety barriers, by the Contractor prior to their leaving the site.
- B. WASTE REMOVAL/DUMP SITES – Contractor shall make all necessary provisions for removal and legal disposal of debris created by his operations from the site. No dumpsite is available on the campus. Contractor shall include all fees for disposal of all waste in their bid price.
- C. WASH DOWNS – Any paved surfaces including walkways, bikeways, streets, etc. shall be washed down by the Contractor and any evidence of construction activity removed prior to final inspection.
- D. CLEAN UP PERIOD – The Contractor must comply with this section for the entire construction period.

**Absolutely no cleaning of brushes or disposal of paint shall be allowed on the grounds of UNCW. Contractor shall coordinate with project manager for approved brush washing areas.**

**XVII. ADDITIONAL SAFETY REQUIREMENTS**

- A. UNCW CONFINED SPACE ENTRY PERMIT - A **UNCW Confined Space Entry Permit** must be obtained from the University Environmental Health and Safety Division by the Contractor immediately after the Contract Award and prior to the commencement of any confined space activity relating to the project.
- B. UNCW ASBESTOS ABATEMENT PERMIT – A **UNCW Asbestos Abatement Permit** must be obtained from the University Environmental Health and Safety Division by the Contractor immediately after the Contract Award and prior to the commencement of any asbestos abatement activity relating to the project.
- C. SMOKING – Smoking is prohibited in all UNCW buildings. Smoking is allowed in designated areas only.

**XVIII. SUPERINTENDENT**

The Contractor shall provide, as a part of the base contract bid, a full-time designated superintendent skilled in the construction trades and project management to direct all work, coordinate subcontractors and with other Contractors, expedite materials, perform inspections, ensure the quality execution of all the requirements of these specifications and to coordinate with the Owner.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**SUPPLEMENTARY GENERAL CONDITIONS**

**XIX. STANDARDS**

All manufactured items and/or fabricated assemblies subject to operation under pressure, operation by connection to an electric source, or operation involving a connection to a manufactured, natural, or LP gas source shall be constructed and approved in a manner acceptable to the appropriate State inspector which customarily requires the label or re-examination listing or identification marking of appropriate safety standard organization, such as the American Society of Mechanical Engineers for pressure vessels; the Underwriters Laboratories and/or National Electrical Manufacturers Association for electrically operated assemblies; or the American Gas Association for gas operated assemblies, where such approvals of listings have been established for the type of device offered and furnished. Further, all items furnished shall meet all requirements of the Occupational Safety and Health Act (OSHA), and State and federal requirements relating to clean air and water pollution.

All equipment and products must be independent third party tested and labeled (UL, FM, or CTS) before final connections to Owner services or utilities.

END OF SUPPLEMENTARY GENERAL CONDITIONS

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**FORM OF PROPOSAL FOR: SINGLE PRIME GENERAL CONTRACTOR SPECIAL PROJECT**

**PROJECT:**     **Trask Coliseum AHU-4 Replacement**  
                  **University of North Carolina at Wilmington, North Carolina**

**SUBMITTED TO:**     Office of Project Management  
                          University of North Carolina at Wilmington  
                          601 South College Road  
                          Wilmington NC 28403-5620

**SUBMITTED BY:**     Bidder's Name: \_\_\_\_\_  
                          Address:           \_\_\_\_\_

License Classification: \_\_\_\_\_ License Number: \_\_\_\_\_

**In compliance with your request for proposals, the undersigned as Bidder hereby proposes to furnish all labor and materials, equipment, operations and incidentals, and to perform all work for the complete execution of the construction entering into the Single Prime Contract for the UNCW **Trask Coliseum AHU-4 Replacement** project at the University of North Carolina at Wilmington, in strict accordance with plans, specifications, contract documents, codes and regulations to the full and entire satisfaction of the Owner for the consideration of the following amount:**

GENERAL CONTRACT: *(Fill in appropriate amounts)*

**LUMP SUM BASE BID:** \_\_\_\_\_ Dollars           (\$ \_\_\_\_\_)

ALTERNATES: Should any of the alternates as described in the contract documents be accepted, the amount written below shall be the amount to be "added to" the base bid.

**ALTERNATE 1:** **Roof hood replacement per Drawings MD103, MH102, M-601 and specification section 233723 - HVAC Gravity Ventilators**

**ALTERNATE 1 BID:** \_\_\_\_\_ Dollars           (\$ \_\_\_\_\_)

**ALTERNATE 2:** Ultrasonic Pipe Testing per Drawings M-001, MP101 and MP102

**ALTERNATE 2 BID:** \_\_\_\_\_ Dollars           (\$ \_\_\_\_\_)

**TIME OF COMPLETION:** Notice to proceed is expected to be issued by **December 23, 2020**. Work shall commence on an agreed-upon time and date with UNCW and must be complete and ready for use by an agreed-upon time and date with UNCW.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

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 party or parties than those herein mentioned have any interest in this proposal or in the contract which may be entered into as a result of acceptance of this proposal; and that this proposal is made without connection with any person, company, corporation or parties making a bid or proposal; and that this proposal 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 informed himself fully with all conditions pertaining to the place where the Work is to be performed; that he has examined the Drawings, Specifications and Instructions for the Work and the Contract Documents relative thereto, and has read all special provisions furnished prior to the Opening of Bids; and that he fully understands and has made every provision to operate under the conditions relative to the Work required by the Contract Documents.

The undersigned further states that he is a duly Licensed Building Contractor in the State of North Carolina under applicable statutes governing his trade, and that all fees, licenses, permits, and charges pertinent to the submission of this Bid have been paid in full.

The undersigned hereby designates the following as his legal address to which such notice of acceptance may be delivered.

---

---

---

---

In compliance with this solicitation, and subject to all conditions herein, the undersigned Bidder offers and agrees to furnish and deliver any or all items which prices are bid, at the prices set opposite each item within the time specified herein. By executing this proposal, the undersigned Bidder certifies:

- ☐ that the proposal is submitted competitively and without collusion (G.S. §143-54),
- ☐ that none of its officers, directors, or owners of an unincorporated business entity has been convicted of any violations of Chapter 78A of the General Statutes, the Securities Act of 1933, or the Securities Exchange Act of 1934 (G.S. §143-59.2), and
- ☐ that it is not an ineligible contractor/vendor as set forth in G.S. §143-59.1.

False certification is a Class I felony. Furthermore, by executing this proposal, the undersigned certifies to the best of Bidder's knowledge and belief, that it and its principals are not disbarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from covered transactions by any Federal or State department or agency.

As required by G.S. §143-48.5, the undersigned Bidder certifies that it, and each of its sub-contractors for any contract awarded as a result of this solicitation, complies with the requirements of Article 2 of Chapter 64 of the NC General Statutes, including the requirement for each employer with more than 25 employees in North Carolina to verify the work authorization of its employees through the E-Verify system.

G.S. §133-32 and Executive Order 24 (2009) prohibit the offer to, or acceptance by, any State Employee associated with the preparing of plans, specifications, estimates for public contract; or awarding or administering of public contracts; or inspecting or supervising delivery of public contracts of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of this responsive Form of Proposal to the Notice to Bidders, the undersigned certifies, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

The Bidder certifies that it:

Is in sound financial condition and, if applicable, has received an unqualified audit opinion for the latest audit of its financial statements.

Has no outstanding liabilities, including tax and judgement liens, to the IRS or any other government entity.

Is current in all amounts due for payments of federal and state taxes and required employment-related contributions and withholdings.

Is not the subject of any current litigation or findings of noncompliance under federal or state law.

Has not been the subject of any past or current litigation, findings in any past litigation, or findings of noncompliance under federal or state law that may impact in any way its ability to fulfill the requirements of this Contract.

The Bidder further proposes and agrees hereby to commence work under his Contract on a date to be specified by the Owner and to fully complete all work required by the Contract specified time frame.

In submitting this bid, it is understood that the Owner reserves the unqualified right to reject any and all proposals.

**Failure to execute/sign this form prior to submittal shall render bid invalid and IT WILL BE REJECTED. Late proposals cannot be accepted.**

He or she is authorized to make the foregoing statements on behalf of the Bidder.

NOTE: This is a continuing certification and Bidder shall notify Owner within 15 days of any material change to any of the representations made herein.

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

Respectfully submitted this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_

\_\_\_\_\_  
Firm or Corporation Making Bid:

By: \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature

Title: \_\_\_\_\_  
(Owner, Partner or Corporation President or Vice-President Only)

\_\_\_\_\_  
Address:

\_\_\_\_\_  
Telephone Number

\_\_\_\_\_  
Fax Number

\_\_\_\_\_  
E-mail Address:

\_\_\_\_\_  
Contractor Classification:

\_\_\_\_\_  
Contractor License Number:

\_\_\_\_\_  
Contractor Federal Tax Identification Number:  
(*Corporate Seal*)

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

The Bidder declares that he has received, reviewed and complied with all instructions issued in the following addenda:

Addenda Received and Considered in Preparing the Bid.  
(Initial as appropriate)

Addendum No. 1	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 2	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 3	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 4	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 5	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 6	Rec'd Date _____	Print Name _____ Signature _____
Addendum No. 7	Rec'd Date _____	Print Name _____ Signature _____

List of Sub-Contractors/Vendors proposed to be used for the Project; include their appropriate license/registration numbers if applicable:

(Mark N/A if not applicable)

<u>Subcontractor/Vendor</u>	<u>License/Registration</u>
_____	_____
_____	_____
_____	_____
_____	_____

**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**ACCEPTANCE OF PROPOSAL**

If any or all parts of this proposal are accepted by the State of North Carolina, an authorized representative of the University of North Carolina at Wilmington shall affix his/her signature hereto and this document and all provisions of the Contract documents as defined in the General Conditions along with the Bidder's Form of Proposal and the written results of any negotiations shall then constitute the written agreement between the parties. A copy of this acceptance will be forwarded to the successful Bidder(s).

FOR UNCW USE ONLY: Offer accepted and Contract awarded this \_\_\_\_ day of \_\_\_\_\_, 20\_\_, as indicated on the attached certification by

\_\_\_\_\_.

(Authorized Representative of the University of North Carolina at Wilmington.)

---

END OF FORM OF PROPOSAL



**UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

**APPLICATION:**

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in University of North Carolina Construction Contracts** are hereby made a part of these contract documents. These guidelines shall apply to all contractors regardless of ownership. Copies of these guidelines may be obtained from The University of North Carolina, (physical address) 910 Raleigh Road, Chapel Hill North Carolina, 27515, (mail address) PO Box 2688, Chapel Hill, North Carolina, 27515-2688, phone (919) 962-1000, Website: [http://www.northcarolina.edu/info/vendors/UNC\\_HUB\\_Guidelines2002\\_Rev 7-10](http://www.northcarolina.edu/info/vendors/UNC_HUB_Guidelines2002_Rev 7-10)

**MINORITY BUSINESS SUBCONTRACT GOALS:**

The goals for participation by minority firms as subcontractors on this project have been set at 10%.

The bidder must identify on its bid (by using the "Identification of Minority Business Participation" form provided in the bid document), the minority businesses that will be utilized on the project with corresponding total dollar value of the bid. In addition, the bidder must submit with his/her bid an affidavit (Affidavit A) listing good faith efforts **or** affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).

The lowest responsible, responsive bidder must provide Affidavit C, if the portion of work to be performed by minority firms is equal to or greater than 10% of the bidder's total contract price. Affidavit C includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, and lists the participating minority firms with the dollar value of their contracts.

**OR**

Provide Affidavit D, if the portion of work to be performed by minority firms is less than 10% of the bidder's total contract price. Affidavit D includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, lists the participating minority firms with the dollar value of their contracts and includes **documentation of Good Faith Effort**.

**OR**

Have provided Affidavit B with his/her bid as noted above, which includes sufficient information for the State to determine that the bidder does not customarily subcontract work on this type project.

**The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.**

**All Bids must include identification of HUB subcontractors (Form HUB-2).**

**Affidavit A or B will be collected at the bid opening.**

**The low bidder will need to submit Affidavit C or D within 72 hours of Notice of Award (if Affidavit B was submitted, no additional documentation is required).**

**Appendix E must be submitted with all invoices or pay applications.**

## SECTION 230000 – GENERAL MECHANICAL

## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. The work shall include furnishing, installing and testing the equipment and materials specified in other sections of the Mechanical Specifications and shown on the Drawings. It is the intent of these Specifications that the mechanical systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.
- B. Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 Specifications Sections bound herewith are a component part of Division 23 specifications. Comply with all provisions, details and instructions of these sections in the accomplishment of work covered under Division 23.
- C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete mechanical systems as shown on the Drawings and specified herein.
- D. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.
- E. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following:
  - 1. Heating, air conditioning and ventilation equipment.
  - 2. Ductwork, air distribution.
  - 3. HVAC piping, specialties and equipment.
  - 4. Controls and wiring.
  - 5. Testing and balancing.
- F. Visit all areas of the site, buildings and structures (as applicable) in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.
- G. Schedule all service interruptions in existing facilities at the Owner's convenience with 24 hours (minimum) notice. Obtain prior approval for each interruption.
- H. Thoroughly test all mechanical systems at the completion of work and make any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

## 1.2 SUBMITTALS

- A. Procedures for submittals: Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

**Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached as Appendix B, for each item of equipment/material or each specification section/paragraph**

- B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.
- C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.
- D. Design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than models indicated is installed, any resulting conflicts with space, maintenance access, clearances or codes are the responsibility of the Contractor to correct at his expense.
- E. Where specific models and manufacturers of materials and equipment are specified, substitutions as allowed by the specifications and State law will be considered. Substitutions must be equivalent in quality, function, suitability and arrangement to specified equipment. Engineer to have final authority as to equivalency of substitutions.
- F. Equipment model numbers noted in these specifications or on the drawings are intended to establish a minimum standard of quality and do not necessarily relate to specific options or arrangement as shown. Provide equipment with all standard features and optional features as stated and arranged as shown on the drawings.

### 1.3 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with all applicable state and local codes, standards and regulations. Furnish all materials and labor which is be required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings. Obtain required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

### 1.4 COORDINATION OF WORK

- A. Contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.
- B. Compare mechanical drawings and specifications with the drawings and specifications for other trades.
- C. Coordinate mechanical installation with the work of other trades. Report any pertinent discrepancies to the Engineer and obtain written instructions for any necessary revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Engineer. No extras will be allowed for rework of uncoordinated installations.

- D. Determine exact route and location of each mechanical item prior to fabrication and/or installation. Adjust location of ducts, piping and equipment, etc., to accommodate interferences anticipated and encountered.
- E. Right of Way: General priority for right of way is as follows:
  - 1. Items located per regulatory requirement.
  - 2. Piping with pitch requirement (plumbing drains, etc.).
  - 3. Ductwork.
  - 4. Piping without pitch requirement.
  - 5. Electrical wiring (conduits, etc.).
- F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.
- G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange ducts, piping and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging doors and access panels.

#### 1.5 EQUIPMENT AND MATERIALS (GENERAL)

- A. Provide all new materials unless specifically indicated otherwise.
- B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.
- C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.
- D. Where equivalent products are submitted, include all associated costs related to substitution in bid.
- E. Furnish materials bearing the manufacturer's name and trade name. Provide UL label where a UL standard has been established for the particular material.
- F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer's latest approved design.
- G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.
- H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft at all times during construction. Provide covers or shelter as required.
- I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

- J. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer's directions. Obtain written instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Engineer at no additional cost.
- K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint entire damaged panel or section per the field painting specifications in Division 9 at no additional cost.

#### 1.6 OPERATION AND MAINTENANCE MANUALS

- A. Refer to individual mechanical sections, drawings and Division 01.

#### 1.7 PAINTING

- A. Contractor must paint replacement ductwork to match existing. Protect sensors, controllers, etc. against painting. Do not install thermostats, devices or trim until painting is complete.

#### 1.8 LOCATIONS AND MEASUREMENTS

- A. Location of mechanical work is shown on the drawings as accurately as possible. Field verify all measurements to ensure that the work suits the surrounding structure, trim, finishes and/or construction. Provide adjustment as necessary.
- B. Make minor relocations of work prior to installation as required or as directed by the Engineer at no additional cost.

#### 1.9 SUPERVISION

- A. Contractor to provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.
- B. Representatives of Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

#### 1.10 QUALITY AND WORKMANSHIP

- A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to present a neat, well finished, and professional installation.
- B. Remove and replace any work considered substandard quality in the judgment of the Engineer.

#### 1.11 CLOSING IN WORK

- A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

## 1.12 CUTTING AND PATCHING

- A. Perform all cutting and patching necessary to install work under this Division. Perform cutting and patching in professional, workmanlike manner. Arrange work to minimize cutting and patching. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Engineer. Cut opening only large enough to allow easy installation of piping, wiring or ductwork. Patching material to match material removed. Restore patched surface to its original appearance at completion of patching. Where waterproofed surfaces are patched, maintain integrity of waterproofing. Remove rubble and excess patching materials from the premises.

## 1.13 INTERPRETATION OF DRAWINGS

- A. Drawings and specifications under this Division are complementary each to the other. Provide any work specified herein and/or indicated on the drawings.
- B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible, but arrange work to suit the finished surroundings and/or trim.
- C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the particular item, system, equipment, etc.
- D. Any omissions from either the drawings or specifications are unintentional. Contractor is responsible for notifying the Engineer of any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

## 1.14 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment to include, but not be limited to, valves, traps, cleanouts, motors, controllers, and dampers. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility. Lack of access doors on drawings does not relieve Contractor of responsibility to provide access doors, if needed to properly service equipment.
- B. Coordinate exact locations and size of access panels for each concealed device requiring service.

## 1.15 ELECTRICAL WORK IN CONNECTION WITH MECHANICAL CONTRACTS

- A. Comply with Division 26. Any required Division 23 electrical work not specifically specified to be furnished by Division 26 Contractor shall be provided by Division 23 Contractor.
- B. The mechanical contractors shall furnish all starters and controls for their equipment. The electrical contractor shall mount starters furnished by the mechanical and plumbing contractors, the electrical contractor provides all safety switches, wiring and connections to line side and load side of starters and safety switches complete to mechanical equipment. For resistance type loads where starters or contactors are not required, the electrical contractor shall provide all

power wiring and connections complete to equipment. The mechanical contractors shall provide all control wiring and connections and devices for their equipment.

- C. All electrical work performed Division 23 shall comply with Division 26 specification requirements. See Division 26 specifications and electrical connection diagrams for division of labor between Divisions 23 and 26.
- D. Coordinate electrical interface of supplied mechanical equipment with electrical system. Division 26 electrical work for mechanical systems is based on values scheduled on mechanical drawings. Division 23 Contractor is responsible for any costs to modify the contracted electrical work to service equipment with electrical characteristics different than those scheduled.

#### 1.16 MECHANICAL WORK IN CONNECTION WITH OTHER CONTRACTS

- A. Provide mechanical services as required for items furnished by other contractors or vendors as shown on the Drawings. Actual requirements may vary from Drawings. Coordinate with equipment installed. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor's presence.

#### 1.17 ALTERNATE BIDS

- A. Alternate Bids, IF ANY, are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specification Sections.

#### 1.18 PROJECT RECORD DRAWINGS

- A. Submit under provisions of relevant sections of the General and Supplemental General Conditions.
- B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the "record drawings."
- C. Record drawings shall accurately show the installed condition of mechanical work.

#### 1.19 PHASING OF THE WORK

- A. Schedule work in accordance with the relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

#### 1.20 PROJECT CLOSEOUT

- A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION (NOT USED)

END OF SECTION 230000

## SECTION 230010 – EXISTING CONDITIONS

## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. Procedures for mechanical work in existing building.

## 1.2 RELATED WORK

- A. Conduct work to minimize interference with adjacent and occupied building areas.
- B. Cease operations immediately if structure appears to be in danger and notify Owner/Engineer. Do not resume operations until directed.

## PART 2 - PRODUCTS

## 2.1 PATCHING MATERIALS

- A. As specified in individual Sections.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Coordinate mechanical service interruptions with the Owner.
- B. Provide temporary and/or permanent mechanical as shown and/or as required by conditions to maintain existing systems in service during construction. Use hot-tapping valves if required.
- C. Existing Mechanical Systems: Maintain existing mechanical systems in service. Disable systems outside construction area only to make tie-ins or switchovers. Obtain permission from the Owner at least 24 hours before partially or completely disabling mechanical. Minimize duration. Make temporary connections as required to maintain service in areas adjacent to work area.
- D. Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.
- E. Field-verify existing conditions as related to interconnection of New Work. Determine exact methods of interface to obtain proper operation.



- F. Coordinate existing and New Work interface prior to beginning any work. Adjust work to suit existing conditions. Some deviations in plan layout vs. actual conditions should be expected.
- G. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

### 3.2 EXISTING CONDITIONS

- A. Verify existing conditions in field and determine which affect mechanical work. Secure utilities as required to prevent spills, leakage, etc.
- B. Protect existing work to remain. Do not cut or remove any structural members.
- C. Rework existing services to remain which interfere with new work.

END OF SECTION 230010

## SECTION 230020 – MECHANICAL DEMOLITION

## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. Selective mechanical demolition.
- B. Conform to the requirements of Section 230000 for cutting and patching.

## 1.2 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent and occupied building areas. Cease operations immediately if structure appears to be in danger and notify Engineer. Do not resume operations until directed.

## 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

## PART 2 - PRODUCTS

## 2.1 PATCHING MATERIALS

- A. As specified in individual Sections.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Demolition Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Engineer before disturbing the existing installation.
- B. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.
- C. Protect existing materials and existing improvements which are not to be demolished.
- D. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.

## 3.2 DEMOLITION

- A. Demolish mechanical work as indicated. Secure utilities as required to prevent spills, leakage, etc.
- B. Demolish in an orderly and careful manner. Protect existing work to remain. Do not cut or remove any structural members.
- C. Terminate all demolition work in a neat finished manner.
- D. Conceal or enclose abandoned work within building construction except as specifically noted.
- E. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- F. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
- G. Coordinate cutting and patching requirements.

END OF SECTION 230020

## SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:

- 1. Thermometers.
  - 2. Gages.
  - 3. Test plugs.

- B. Related Sections:

- 1. Section 231113 "Hydronic Piping."

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## 1.6 SPARE PARTS

- A. Provide one spare certified calibrated gauge of each type to be utilized for testing/comparison purposes.

## PART 2 - PRODUCTS

## 2.1 LIGHT-ACTIVATED THERMOMETERS

- A. Direct-Mounted, Light-Activated Thermometers:

- 1. Case: Metal; 7-inch nominal size unless otherwise indicated.
  - 2. Scale(s): Deg F and deg C.

3. Case Form: Adjustable angle.
4. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
5. Stem: Aluminum and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

6. Display: Digital.
7. Accuracy: Plus or minus 2 deg F.

## 2.2 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Brass.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 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 piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass 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. Description: Test-station fitting made for insertion into piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- E. Core Inserts: EPDM self-sealing rubber.

## 2.6 TEST-PLUG KITS

- A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- B. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- D. 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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install valve and syphon fitting in piping for each pressure gage for steam.

- I. Install test plugs in piping tees.
- J. Install flow indicators in piping systems in accessible positions for easy viewing.
- K. Install connection fittings in accessible locations for attachment to portable indicators.
- L. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic coil in air-handling units.
- M. Install pressure gages in the following locations:
  - 1. Suction and discharge of each pump.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic coil in air-handling units shall be the following:
  - 1. Direct-mounted, light-activated type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range: 0 to 250 deg F.

### 3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at suction and discharge of each pump shall be the following:
  - 1. Sealed, direct-mounted, metal case.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range: 0 to 100 psi.

END OF SECTION 230519

## SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:

- 1. Bronze ball valves.

## 1.3 DEFINITIONS

- A. CWP: Cold working pressure.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

- 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and weld ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.

- 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.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

## PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:



1. ASME B1.20.1 for threads for threaded-end valves.
  2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  3. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Refer to HVAC valve schedule articles for applications of valves.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
  2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
  3. Memory stops that are fully adjustable after insulation is applied.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BRONZE BALL VALVES
- A. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:
    - a. Standard: MSS SP-110.
    - b. CWP Rating: 600 psig.
    - c. Body Design: Two piece.
    - d. Body Material: Bronze.
    - e. Ends: Threaded.
    - f. Seats: PTFE.
    - g. Stem: Stainless steel.
    - h. Ball: Stainless steel, vented.
    - i. Port: Full.

## 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. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.

### 3.4 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Two-piece, full port, bronze with stainless-steel trim.

END OF SECTION 230523.12

## SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. High-performance butterfly valves.

## 1.2 ACTION SUBMITTALS

## A. Product Data: For each type of valve.

## PART 2 - PRODUCTS

## A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

## B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.1 for power piping valves.
4. ASME B31.9 for building services piping valves.

## C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

## D. Valve Sizes: Same as upstream piping unless otherwise indicated.

## E. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.

## F. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

## 2.2 HIGH-PERFORMANCE BUTTERFLY VALVES

## A. Single-Flange, High-Performance Butterfly Valves, Class 150:

## 1. Description:

- a. Standard: MSS SP-68.
- b. CWP Rating: 285 psig at 100 deg F.

- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- e. Seat: Reinforced PTFE or metal.
- f. Stem: Stainless steel; offset from seat plane.
- g. Disc: Carbon steel.
- h. Service: Bidirectional.

### PART 3 - EXECUTION

#### 3.1 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. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

#### 3.2 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.

#### 3.3 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 and Larger:
  - 1. High-Performance Butterfly Valves: Single flange, Class 150.

END OF SECTION 230523.13

## SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Bronze swing check valves.
  - 2. Iron swing check valves.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

## PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.1 for flanges on iron valves.
  - 2. ASME B31.9 for building services piping valves.
- C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE SWING CHECK VALVES

- A. Class 150, Bronze Swing Check Valves with Bronze Disc:
  - 1. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 300 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze.

## 2.3 IRON SWING CHECK VALVES

### A. Iron Swing Check Valves with Metal Seats, Class 125:

#### 1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

## PART 3 - EXECUTION

### 3.1 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. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

### 3.2 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.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  1. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:

1. For Steel Piping: Flanged ends.
2. For Copper Tubing, NPS 2 and Smaller: Threaded ends.

### 3.4 HEATING-WATER VALVE SCHEDULE

#### A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 150, bronze disc.

#### B. Pipe NPS 2-1/2 and Larger:

1. Iron swing check valves with metal seats, Class 125.

END OF SECTION 230523.14

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

## 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

## 1.4 ACTION SUBMITTALS

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

## 1.5 QUALITY ASSURANCE

- A. 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

- A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

- B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.



2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated 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 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 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.

## 2.5 EQUIPMENT SUPPORTS

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

## 2.6 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, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. 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 Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- 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 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.
- 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.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
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.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
5. 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:
  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 and metal trapeze pipe hangers and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  13. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  14. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  15. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
  16. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  17. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  18. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. C-Clamps (MSS Type 23): For structural shapes.
  6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  9. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  10. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
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.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:

- 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Valve tags.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

## PART 2 - PRODUCTS

## 2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

- 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: White.
  - 3. Background Color: Black.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment.

- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

## 2.3 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link chain.
- 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.

## 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 encapsulants.



### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. For concealed valves, dampers, equipment, and devices needing service, provide identification markers visible from floor. Use color dot stickers placed on ceiling grid where valves, dampers, equipment, and devices needing service are installed above. Color scheme to be in accordance with Owner's color-coding standard.

### 3.3 EQUIPMENT LABEL INSTALLATION

- A. All major HVAC equipment, including air handlers, air terminal units, fans and pumps shall be properly identified with equipment tag stating equipment ID, ratings and date of installation. Permanent labeling shall be in accordance with NCMC 301.6.
- B. Install or permanently fasten labels on each major item of mechanical equipment.
- C. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: 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 and on both sides of 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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
  - 1. Heating -Water Piping: White letters on a safety-green background.
  - 2. Chilled -Water Piping: White letters on a safety-green background
  - 3. Refrigerant Piping: White letters on a safety-purple background.

### 3.5 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.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Heating Hot Water: 2 inches, round.
  - 2. Valve-Tag Colors:
    - a. Heating Hot Water: White letters on a safety-green background.

### 3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:

- 1. Balancing Air Systems:
  - a. Variable-air-volume systems.
- 2. Balancing Hydronic Piping Systems:
  - a. Variable-flow hydronic systems.
- 3. Testing, Adjusting, and Balancing Equipment:
  - a. Motors.
  - b. Condensing units.
  - c. Heat-transfer coils.
- 4. Control system verification.

## 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualification to perform TAB work.
- G. TDH: Total dynamic head.

## 1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

## 1. Minimum Agenda Items:

- a. The Contract Documents examination report.
- b. The TAB plan.
- c. Needs for coordination and cooperation of trades and subcontractors.
- d. Proposed procedures for documentation and communication flow.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Record log of duct leakage tests submitted to designer and/or commissioning agent upon completion.
- I. Instrument calibration reports, to include the following:
  1. Instrument type and make.
  2. Serial number.
  3. Application.
  4. Dates of use.
  5. Dates of calibration.

## 1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by NEBB or AABC.
  1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or AABC.
  2. TAB Technician: Employee of the TAB specialist and certified by NEBB or AABC as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

## 1.7 FIELD CONDITIONS

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

## 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 installed systems for 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 applicable for intended purpose and 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 equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

- K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - 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.
  - 2. Hydronics:
    - 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 per 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 gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.

- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. 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 AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- 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, patch probe holes in ducts with same material and thickness as used to construct ducts. Mark exterior of repaired duct insulation with location of test holes for Commissioning purposes.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation" and Section 230719 "HVAC Piping Insulation."
- 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. Cross-check 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. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. 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.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

#### A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. For belt-driven exhaust fan, balance at or above 90% of the maximum speed utilizing pulley and/or sheave adjustment.
4. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
5. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
  - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
  - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
  - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
  - d. Adjust controls so that terminal is calling for minimum airflow.
  - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
  - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
  - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
6. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
  - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
7. Measure fan static pressures as follows:



- a. Measure static pressure directly at the fan outlet or through the flexible connection.
  - b. Measure static pressure directly at the fan inlet or through the flexible connection.
  - c. Measure static pressure across each component that makes up the air-handling system.
  - d. Report any artificial loading of filters at the time static pressures are measured.
8. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
  - b. Verify that terminal units are meeting design airflow under system maximum flow.
9. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
10. Verify final system conditions as follows:
  - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
  - b. Re-measure and confirm that total airflow is within design.
  - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
  - d. Mark final settings.
  - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
  - f. Verify tracking between supply and return fans.

### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
  1. Check liquid level in expansion tank.
  2. Check highest vent for adequate pressure.
  3. Check flow-control valves for proper position.
  4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
  5. Verify that motor starters are equipped with properly sized thermal protection.
  6. Check that air has been purged from the system.
  7. Adjust expansion tank pressure to make-up water pressure.

### 3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
  1. Measure total water flow.
    - a. Position valves for full flow through coils.

- b. Measure flow by main flow meter, if installed.
    - c. Determine flow by pump TDH.
  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 gage heights.
    - 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.
  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.

### 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
  - 1. Verify that the differential-pressure sensor is located as indicated.
  - 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
  - 1. Adjust pumps to deliver total design gpm.
    - a. Measure total water flow.
      - 1) Position valves for full flow through coils.
      - 2) Measure flow by main flow meter, if installed.
      - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    - b. Measure pump TDH as follows:
      - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      - 3) Convert pressure to head and correct for differences in gage heights.
      - 4) 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.
      - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
  - 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
    - a. Measure flow in main and branch pipes.
    - b. Adjust main and branch balance valves for design flow.
    - c. Re-measure each main and branch after all have been adjusted.
  - 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    - a. Measure flow at terminals.
    - b. Adjust each terminal to design flow.
    - c. Re-measure each terminal after it is adjusted.
    - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    - e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
    - a. Measure differential pressure and verify that it is within manufacturer's specified range.
    - b. Perform temperature tests after flows have been verified.
  5. For systems without pressure-independent valves or flow-measuring devices at terminals:
    - a. Measure and balance coils by either coil pressure drop or temperature method.
    - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
  6. Prior to verifying final system conditions, determine the system differential-pressure set point.
  7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
  8. Mark final settings and verify that all memory stops have been set.
  9. Verify final system conditions as follows:
    - a. Re-measure and confirm that total water flow is within design.
    - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    - c. Mark final settings.
  10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
  2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
  3. Adjust pumps to deliver total design gpm.
    - a. Measure total water flow.
      - 1) Position valves for full flow through coils.
      - 2) Measure flow by main flow meter, if installed.
      - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    - b. Measure pump TDH as follows:
      - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      - 3) Convert pressure to head and correct for differences in gage heights.
      - 4) 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.

- 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
  - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
  - a. Measure flow in main and branch pipes.
  - b. Adjust main and branch balance valves for design flow.
  - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
  - a. Measure flow at terminals.
  - b. Adjust each terminal to design flow.
  - c. Re-measure each terminal after it is adjusted.
  - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
  - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
  - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
  - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
  - a. Measure and balance coils by either coil pressure drop or temperature method.
  - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
  - a. Re-measure and confirm that total water flow is within design.
  - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  - c. Mark final settings.
13. Verify that memory stops have been set.

### 3.9 PROCEDURES FOR MOTORS

- 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. Phase and hertz.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter size and thermal-protection-element rating.
  - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.
- C. Record final motor speed or frequency at balanced conditions in addition to nameplate speed.

### 3.10 PROCEDURES FOR HEAT-TRANSFER 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 for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
  - 1. Nameplate data.
  - 2. Airflow.
  - 3. Entering- and leaving-air temperature at full load.
  - 4. Voltage and amperage input of each phase at full load.
  - 5. Calculated kilowatt at full load.
  - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Airflow.
  - 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Wet-bulb temperature of entering and leaving air.
  - 3. Airflow.

### 3.11 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  - 1. Verify temperature control system is operating within the design limitations.
  - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
  - 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.

### 3.12 TOLERANCES

- A. Set HVAC system's airflow 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 (other): Plus or minus 10 percent.
  - 3. Hydronic-Water Flow Rate: Plus or minus 5 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.13 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.14 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.
  - 3. Certify validity and accuracy of field data.

- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; 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 the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump 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. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. 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 with coils, 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 rpm.
    - 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 rpm.
    - d. Discharge static pressure in inches wg.
    - e. Filter static-pressure differential in inches wg.
    - f. Preheat-coil static-pressure differential in inches wg.
    - g. Cooling-coil static-pressure differential in inches wg.
    - h. Outdoor airflow in cfm.
    - i. Return airflow in cfm.
    - j. Outdoor-air damper position.
    - k. Return-air damper position.
    - l. Pressure set-point in inches wg.
- 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.

- 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.
  - o. Inlet steam pressure in psig.
- G. 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 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.
- H. Air-Terminal-Device Reports:
  - 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.

- i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
  - a. Airflow rate in cfm.
  - b. Air velocity in fpm.
  - c. Preliminary airflow rate as needed in cfm.
  - d. Preliminary velocity as needed in fpm.
  - e. Final airflow rate in cfm.
  - f. Final velocity in fpm.
  - g. Final calibration factor for achieving design air flow.
  - h. Individual inlet and outlet readings and sum at maximum air flow rate and at minimum air flow rate in cfm.
  - i. Space temperature in deg F.
- I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
  1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm.
    - g. Water pressure differential in feet of head or psig.
    - h. Required net positive suction head in feet of head or psig.
    - i. Pump rpm.
    - j. Impeller diameter in inches.
    - k. Motor make and frame size.
    - l. Motor horsepower and rpm.
    - m. Voltage at each connection.
    - n. Amperage for each phase.
    - o. Full-load amperage and service factor.
    - p. Seal type.
  2. Test Data (Indicated and Actual Values):
    - a. Static head in feet of head or psig.
    - b. Pump shutoff pressure in feet of head or psig.
    - c. Actual impeller size in inches.
    - d. Full-open flow rate in gpm.
    - e. Full-open pressure in feet of head or psig.
    - f. Final discharge pressure in feet of head or psig.
    - g. Final suction pressure in feet of head or psig.
    - h. Final total pressure in feet of head or psig.
    - i. Final water flow rate in gpm.
    - j. Voltage at each connection.
    - k. Amperage for each phase.
    - l. Pressure set-point in feet of head or psig.

J. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager and commissioning authority. Prepare test and inspection reports.
- B. Verification of TAB will include 10% of all redundant equipment such as terminal units. Verification of TAB will include limited readings of 100% of major equipment (all AHUs, EFs, etc.).
- C. 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."
- D. 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.
- E. If TAB work fails, proceed as follows:
  1. TAB specialists shall 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 specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
  3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

## SECTION 230719 - HVAC PIPING INSULATION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Chilled-water piping, indoors.
3. Heating hot-water piping, indoors.

## 1.3 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).

## 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. 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. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

#### 1.6 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.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping."
- 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.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. 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.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Block Insulation: ASTM C 552, Type I.
  - 2. Special-Shaped Insulation: ASTM C 552, Type III.
  - 3. Board Insulation: ASTM C 552, Type IV.
  - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

## 2.3 ADHESIVES

- A. Materials 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. 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.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- F. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

## 2.5 SEALANTS

A. Cellular-Glass Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Service Temperature Range: Minus 100 to plus 300 deg F.
3. Color: White or gray.

B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

## 2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: Color-code jackets based on system. Color as selected by Owner.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.



- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.9 SECUREMENTS

- A. Bands:
  - 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
  - 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## 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.
  - 3. 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.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. 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.

- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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 4 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 pipe flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.
- O. 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.

### 3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- 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 indicated. Installation shall conform to the following:
  1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 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.
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.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers 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 manufacturers 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.

### 3.8 INSTALLATION OF MINERAL-FIBER INSULATION

#### 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.

### 3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

### 3.10 FINISHES

- A. Color: Match color of existing. Vary first and second coats to allow visual inspection of the completed Work.

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, and three locations of threaded valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 3/4 inch thick.
- B. Chilled Water and Brine, above 40 Deg F:
  - 1. NPS 12 and Smaller: Insulation shall be the following:
    - a. Cellular Glass: 2 inches thick.



C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 12 and Smaller: Insulation shall be the following:
  - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.14 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
  1. None.
  2. PVC, Color-Coded by System: 20 mils thick.

## SECTION 230900 - BUILDING MANAGEMENT SYSTEM

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Building Management System (BMS), utilizing direct digital controls.

## 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Products Supplied but Not Installed Under This Section:
  - 1. Control valves.
  - 2. Flow switches.
  - 3. Wells, sockets and other inline hardware for water sensors (temperature, pressure, flow).
  - 4. Automatic control dampers, where not supplied with equipment.
  - 5. Airflow measuring stations.
  - 6. Terminal unit controllers and actuators, when installed by terminal unit manufacturer.
  - 7. Variable frequency drives. (This does not include VFDs integral to machinery such as chillers or boilers).
- B. Products Installed but Not Supplied Under This Section:
  - 1. None.
- C. Products Not Furnished or Installed but Integrated with the Work of This Section:
  - 1. Smoke detectors (through alarm relay contacts).
- D. Work Required Under Other Divisions Related to This Section:
  - 1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
  - 2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
  - 3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.

## 1.3 SYSTEM DESCRIPTION

- A. Scope: Furnish all labor, materials and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section must communicate on a peer-to-peer bus over a LonTalk, BACnet, or IP Based open protocol bus. All controllers on the LonTalk bus must be LonMark certified.
  - 1. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
  - 2. System architecture must fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and MODBUS.
  - 3. System architecture must provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
  - 4. All control devices, including configurable and fully programmable controllers, furnished with this Section must be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools must not be acceptable.
  - 5. Any control vendor that must provide additional BMS server software must be unacceptable. Only systems that utilize the Niagara 4 Framework must satisfy the

- requirements of this section.
6. The BMS server must host all graphic files for the control system. All graphics and navigation schemes for this project must match those that are on the existing campus NiagaraAX or Niagara 4 Framework server.
  7. A new laptop computer including engineering/programming software to modify Operating System Server BMS programs and graphics must be included. An IPAD may be requested for monitoring of building operations and graphic access and will be job specific per a request by UNCW if required (Owner's discrepancy)
  8. Owner must receive all Administrator level login and passwords for engineering toolset at first training session. The Owner must have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS. UNCW will be responsible for setting up desired user accounts with necessary access limits per each user's requirements and allowances.
  10. OPEN NIC STATEMENTS - All Niagara 4 software licenses must have the following NiCS: "accept.station.in=\*"; "accept.station.out=\*"and "accept.wb.in=\*"and "accept.wb.out=\*". All open NIC statements must follow Niagara Open NIC specifications.
  11. All JACE hardware licenses and certificates must be stored on local MicroSD memory card employing encrypted "safe boot" technology.
  12. All JACE's provided as part of this project must be the appropriate JACE-8000 model licensed with all necessary drivers.
  13. Approved Manufacturers: Honeywell, TAC I/A Series, Distech, Trane.
  14. Approved Installation Contractors: Engineered Control Solutions, Schneider Electric CMS Controls

#### 1.4 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state over stated range of values.
5. BMS: Building Management System.
6. DDC: Direct Digital Control.
7. Discrete: Binary or digital state.
8. DI: Discrete Input.
9. DO: Discrete Output.
10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
12. GUI: Graphical User Interface.
13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
18. Motorized: Control device with actuator.
19. NAC: Network Area Controller.

- 20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
- 21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
- 22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
- 23. Operator: Same as actuator.
- 24. PC: Personal Computer.
- 25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
- 26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
- 27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
- 28. PICS: BACnet Product Interoperability Compliance Statement.
- 29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
- 30. Point: Analog or discrete instrument with addressable database value.
- 31. WAN: Wide Area Network.

#### 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Submit documentation of contractor qualifications, including those indicated in "Quality Assurance" if requested by the A-E.
- D. Electronic copies of shop drawings of the entire control system must be submitted and must consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope must be included for approval.
- E. Shop drawings must also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring must be shown on the shop drawings.
- F. Upon completion of the work, provide three (3) complete sets of 'as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and one electronic copy.
- G. Any deviations from these specifications or the work indicated on the drawings must be clearly identified in the Submittals.
- H. All control panels associated with a field device such as air handlers and water systems must

have a laminated page copy of the writing schematic and detail attached to the control cabinet.

- I. A software copy of the controls as-built must be supplied and downloaded to the local system network controller (SNC) in 2 different formats. One PDF format and another in the format (Visio) used to produce and engineer the original document as to allow UNCW to modify the as-builts in future changes, construction, and modifications to the controls system.

#### 1.6 QUALITY ASSURANCE

- A. The Control System Contractor must have a full service DDC office within 50 miles of the job site. This office must be staffed with applications engineers, software engineers and field technicians. The Control System Contractor must be staffed with a minimum of ten (10) Niagara 4 certified software engineers and/or technicians. The Control System Contractor must maintain parts inventory and must have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.
- B. Single Source Responsibility of Supplier: The Control System Contractor must be responsible for the complete installation and proper operation of the control system. The Control System Contractor must exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor must be the manufacturer of the primary DDC system components or must have been the authorized representative for the primary DDC components manufacturer for at least 10 years. All control panels must be assembled by the Control System Contractor in a UL-Certified 508A panel shop. Control panels must be assembled such that all necessary I/O points are pre-wired to terminal blocks. Wire ducts must be installed within the panel as needed to accommodate field wiring.
- C. Equipment and Materials: Equipment and materials must be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products must be manufacturer's latest standard design and have been tested and proven in actual use.

#### 1.7 SOFTWARE OWNERSHIP

- A. The Owner must have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

#### 1.9 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It must be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

#### 1.10 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. The Building Management System (BMS) must be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.
- B. The installed system must provide secure strong password access to all features, functions and data contained in the overall BMS.

### 2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing the LonWorks technology communication protocol in one open, interoperable system.
- B. The supplied computer software must employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, must be via Ethernet or IP.
- C. All components and controllers supplied under this contract must be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data must not be acceptable.
- D. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data must reside on the Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs must not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture must not be acceptable.
  - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation must not exceed 5 seconds for network connected user interfaces.
  - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation must not exceed 60 seconds for remote or dial-up connected user interfaces.

### 2.3 BAS SERVER HARDWARE (Provided by Owner)

- A. Minimum Computer Configuration (Hardware Independent).
  - 1. Central Server. Owner must provide a dedicated BAS server with configuration that includes the following components as a minimum:
  - 2. Processor: Intel Xeon CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors.
  - 3. Memory: 8 GB or more.
  - 4. Hard Drive: 80 GB minimum, more recommended depending on archiving requirements.

5. Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater.
  6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector).
  7. Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem).
- B. Standard Client: The thin-client Web Browser BAS GUI must be Microsoft Internet Explorer (10.0 or later) running on Microsoft 7+. No special software must be required to be installed on the PCs used to access the BAS via a web browser.

## 2.4 SYSTEM NETWORK CONTROLLER (SNC)

- A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC) and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.
- B. The controllers must be fully programmable to meet the unique requirements of the facility it must control.
- C. The controllers must be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.
- D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.
- E. The SNC must employ a device count capacity license model that supports expansion capabilities.
- F. The SNC must be enabled to support and must be licensed with the following Open protocol drivers (client and server) by default:
1. BACnet
  2. Lon
  3. MODBUS
  4. SNMP
  5. KNX
- G. The SNC must be capable of executing application control programs to provide:
1. Calendar functions.
  2. Scheduling.
  3. Trending.
  4. Alarm monitoring and routing.
  5. Time synchronization.
  6. Integration of LonWorks, BACnet, and MODBUS controller data.
  7. Network management functions for all SNC, PEC and ASC based devices.
- H. The SNC must provide the following hardware features as a minimum:
1. Two 10/100 Mbps Ethernet ports.
  2. Two Isolated RS-485 ports with biasing switches.
  3. 1 GB RAM

4. 4 GB Flash Total Storage / 2 GB User Storage
  5. Wi-Fi (Client or WAP)
  6. USB Flash Drive
  7. High Speed Field Bus Expansion
  8. -20-60°C Ambient Operating Temperature
  9. Integrated 24 VAC/DC Global Power Supply
  10. MicroSD Memory Card Employing Encrypted Safe Boot Technology
- I. The SNC must support standard Web browser access via the Intranet/Internet. It must support a minimum of 16 simultaneous users.
- J. The SNC must provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- K. The SNC must be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
1. Alarm generation must be selectable for annunciation type and acknowledgement requirements including but not limited to:
    - a. Alarm.
    - b. Return to normal.
    - c. To default.
  2. Alarms must be annunciated in any of the following manners as defined by the user:
    - a. Screen message text.
    - b. Email of complete alarm message to multiple recipients.
    - c. Pagers via paging services that initiate a page on receipt of email message.
    - d. Graphics with flashing alarm object(s).
  3. The following must be recorded by the SNC for each alarm (at a minimum):
    - a. Time and date.
    - b. Equipment (air handler #, access way, etc.).
    - c. Acknowledge time, date, and user who issued acknowledgement.
  4. Alarms classes must be created in the local station to match N4 Supervisor class naming in the following manner with same naming for priority routing and annunciation. (listed in order of priority from highest to lowest)
    - a. Critical Alarms (Priority 1)
    - b. High Priority (Priority 2)
    - c. Space Temp Alarms (Priority 3)
    - d. Generator Alarms (Priority 3) (if required)
    - e. Plumbers Alarms (Priority 3) (if required)
    - f. Mid Priority (Priority 4)
    - g. Low Priority (Priority 5)
    - h. Ping Alarms (Priority 6)
    - i. \*Back to normal state (Priority 7)\*
  5. All alarm classes in the local station must be directed to the N4 station recipient for routing. The Supervisors "Supervisor Console" should be added to a Px view accessible via a hyperlink with a filter applied to show only the selected buildings alarms on the appropriate buildings' graphics alarm page.
    - a. Time Stamp
    - b. Source
    - c. Source State
    - d. Alarm State
    - e. Priority



- f. Alarm Class
  - g. Ack or Clear Action link
- L. Programming software and all controller "Setup Wizards" must be embedded into the SNC.
- M. The SNC must support the following security functions.
  - 1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
  - 2. Role-Based Access Control (RBAC) for managing user roles and permissions.
  - 3. Require users to use strong credentials.
  - 4. Data in Motion and Sensitive Data at Rest be encrypted.
  - 5. LDAP and Kerberos integration of access management.
- N. The SNC must support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
  - 1. Metadata: Descriptive tags to define the structure of properties.
  - 2. Tagging: Process to apply metadata to components
  - 3. Tag Dictionary
- O. The SNC must employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AVAV, CVAV, VFD) must have an associated template file for reuse on future project additions.
- P. The SNC point naming must follow a standard as set for a standardized naming convention. This naming standard must be applied to the SNC as well as the BAS Server Supervisor for all points related to setpoints, monitoring points, trending, alarming, and graphics
- Q. The SNC must be provided with a 1 Year Software Maintenance license. Labor to implement not included.

## 2.5 BUILDING AUTOMATION SYSTEM CONTROLLERS

- A. HVAC control must be accomplished using LonMark based devices. The controller platform must provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
  - 1. Programmable Equipment Controllers - a controller designed for more complex sequences of operations such as built up AHU's, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. The PECs are to allow for the flexibility of custom control programming to meet the needed sequences of operation. PEC's must be selected based upon I/O requirements. Additional I/O may be added via expansion modules.
    - a. All PECs must be application programmable and must at all times maintain their certification. All control sequences within or programmed into the PEC must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
    - b. The PEC must provide LED indication of communication and controller performance to the technician, without cover removal.
    - c. PEC's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC or relay).

2. Advanced Variable Air Volume Controller (AVAV) - a controller designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO<sub>2</sub>, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals and constant volume dual-duct terminal unit.
  - a. The AVAV must be application programmable and must at all times maintain their certification. All control sequences within or programmed into the PEC must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
  - b. The controller must have an internal velocity pressure sensor.
  - c. The AVAV must provide LED indication of communication and controller performance to the technician, without cover removal.
  - d. AVAV's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).
  - e. The controller must provide an integrated actuator option.
3. Configurable VAV Controller (CVAV) - the configurable VAV controller platform must be designed specifically for room-level VAV control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO<sub>2</sub>, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals, and constant volume dual-duct terminal unit.
  - a. The CVAV must be application specific configuration and must at all times maintain their certification. All control sequences within or programmed into the CVAV must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
  - b. The controller must have an internal velocity pressure sensor.
  - c. The CVAV must provide LED indication of communication and controller performance to the technician, without cover removal.
  - d. CVAV's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).
  - e. The controller must provide an integrated actuator option.
4. Configurable Constant Volume AHU Controller (CVAHU) - the configurable constant volume AHU controller must be designed specifically for single zone unitary AHU control –temperature, humidity, complex CO<sub>2</sub>, occupancy, and emergency control. Equipment includes: unitary air handling units, fan coil units, blower coil units, unit ventilators, and heat pumps.
  - a. The CVAHU controller must be application specific configuration and must at all times maintain their certification. All control sequences within or programmed into the CVAHU controller must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
  - b. The CVAHU controller must provide LED indication of communication and controller performance to the technician, without cover removal.
  - c. CVAHU controllers must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).

## 2.6 OTHER CONTROL SYSTEM HARDWARE

- A. Utility metering devices, (water, electric, and gas) must be non-pulse devices with non-volatile memory communicated directly to a gateway such as SCADA metrics Ethermeter, Onicon D-100, or kW switchgear meters which will be communicated to the building and supervisor Niagara system.
- B. HVAC local non-programmable and non-configurable integration devices, (boilers, VFD's, and utility meters) must use LonMark, BACnet, Modbus, or IP based devices to communicate.
- C. Motorized control dampers that will not be integral to the equipment must be furnished by the Control System Contractor.
  - 1. Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners. Welded frames shall not be acceptable.
  - 2. Blades shall be maximum 6.4" (162.6 mm) deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06" (1.52mm), clear anodized to a minimum thickness of 0.7 mil (18 microns) deep. All blades shall be symmetrically pivoted.
  - 3. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.
  - 4. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.
  - 5. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable. Bearings are to be maintenance-free, requiring no lubrication.
  - 6. Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be stainless steel.
  - 7. Linkage hardware shall be aluminum and stainless steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with stainless steel cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.
  - 8. Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).
  - 9. Dampers shall be AMCA rated for Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
  - 10. Dampers shall be custom made to required size, with blade stops not exceeding 1¼" (31.7 mm) in height. The blade stop shall be a continuous and integral part of the head/sill. Welded and caulked blade stops shall not be acceptable.
  - 11. Dampers shall be opposed blade or parallel blade action, as indicated on the plans.
  - 12. Field-supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

- D. Control Valves: Control valves must be 2-way or 3-way pattern as shown and constructed for tight shutoff at the pump shut-off head or steam relief valve pressure. Control valves must operate satisfactorily against system pressures and differentials. Two-position valves must be 'line' size. Proportional control valves must be sized for a maximum pressure drop of 5.0 psi at rated flow (unless otherwise noted or scheduled on the drawings). Valves with sizes up to and including 2 inches (51 mm) must be "screwed" configuration and 2-1/2 inches (63.5 mm) and larger valves must be "flanged" configuration. All control valves, including terminal unit valves, less than 2 inches (51 mm) must be globe valves. Electrically-actuated control valves must include spring return type actuators sized for tight shut-off against system pressures (as specified above) and, when specified, must be furnished with integral switches for indication of valve position (open-closed). Pneumatic actuators for valves, when utilized, must be sized for tight shut-off against system pressures (as specified above).
- E. Control Valve Actuators: Actuators for VAV terminal unit heating coils must be "drive-open; drive-closed" type. All actuators must have inherent current limiting motor protection. Valve actuators must be 24-volt, electronic type, modulating or two-position as required for the correct operating sequence. Actuators on valves needing 'fail-safe' operation must have spring return to Normal position. Modulating valves must be positive positioning in response to the signal. All valve actuators must be UL listed. Honeywell is basis of design.
- F. All control valves 2-1/2 inches (63.5 mm) or larger must have position indication. All hot water control valves must be Normally-Open arrangement; all chilled water control valves must be Normally-Closed arrangement.
- G. Wall Mount Room Temperature sensors: Each room temperature sensor must provide temperature indication to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors must be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor must be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices must have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range.
- H. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of  $\pm$  0.2 degrees C. Outside air sensors must include an integral sun shield. Duct-mounted sensors must have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F (-38 to 71 degrees C) The sensor must include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet (2438 mm) long sensor element. These devices must have accuracy of 0.5 degrees F (.024 degrees C) over the entire range.
- I. Humidity sensors must be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range must be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors must be selected for wall, duct or outdoor type installation as appropriate. Honeywell is basis of design.
- J. Carbon Dioxide Sensors (CO<sub>2</sub>): Sensors must utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range must be 0 - 2000 PPM. Accuracy must be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response must be less than one minute. Input voltage must be 20 to 30 VAC or DC. Output must be 0 - 10 VDC. Sensor must be wall or duct mounted type, as appropriate for the application, housed in a high impact

plastic enclosure.

- K. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
- L. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy must be plus or minus 1% of full range; range must be selected for the specific application. Provide zero and span adjustment capability. Device must have integral static pickup tube.
- M. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches must have adjustable set points and barbed pressure tips.
- N. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch must be UL listed.
- O. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel must be factory wired. Control panel must be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of 'as-built' control drawings (relating to the controls within that panel) must be furnished within each control panel.
- P. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with and accuracy of  $\pm 1\%$  accuracy. Their range must be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors must be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel must be included.
- Q. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.
- R. Variable Frequency Drives: The variable frequency drive (VFD) must be designed specifically for use in Heating, Ventilation, and Air Conditioning (HVAC) applications in which speed control of the motor can be applied. The VFD, including all factory installed options, must have UL & CSA approval. VFD's must include communications capability with DDC BMS via built-in interface card (MODBUS or BACnet). Honeywell SmartVFD is basis of design.
- S. Relays: Start/stop relay model must provide either momentary or maintained switching action as appropriate for the motor being started. All relays must be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels must all be DPDT with indicating lamp. Relays installed outside of controlled devices must be enclosed in a NEMA enclosure suitable for the location. Relays must be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.
- T. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch must be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF."
- U. Transducers: Differential pressure transducers must be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts must be stainless steel. Unit must be designed to operate in the pressure ranges involved.

- V. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers must be sized for the load, but must be sized for 50 watts, minimum. Transformers must be UL listed Class 2 type, for 120 VAC/24 VAC operation.
  - W. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits must be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection must meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), must be brought to each control panel.
  - X. Lon Bus Surge Protectors: A Lon Bus Surge Protector, DITEK model # DTK-2MHL24BWB or equivalent must be installed on the lon bus when it leaves and enters a building.
  - Y. Ethernet Port Surge Protector: An Ethernet Surge protector must be installed similar to the Honeywell 14507678-004 or comparable.
  - Z. Airflow Monitoring Stations: Ebtron Brand airflow monitoring stations must be Lon. Controls Contractor must verify installed duct sizes and airflows before ordering.
  - AA. Gas Meters: Onicon brand F-5400 Series Thermal Mass Flow Meter, D-100 display with LonWorks TP/FT-10F Output. Controls Contractor must verify installed pipe size, meter placement sizes and flows before ordering.
  - BB. Domestic Water Meters:
    - 1. Building meters: Neptune with Neptune E-Coder register w/ the potted cable.
      - a. 1.5 inches and below must be positive displacement type with matching strainer.
      - b. 2 inches and above must be compound type meter with matching strainer.
    - 2. Irrigation meters: Neptune
      - a. Minimum 2" turbine meter with matching strainer
    - 3. Meter Register: Neptune E-Coder register w/ the potted cable. (The R900i register is NOT compatible, since it does not feature a connection wire.)
    - 4. Meter Gateway: Scadаметrics Ethermeter <http://www.scadаметrics.com/> The gateway device must directly interrogate the meter register and must calculate and relay the following parameters to the BMS: Totalized Volume, Instantaneous Flowrate
  - CC. BTU Meters: Onicon System-10 BTU meter, LonWorks communication, F-3500 Electromagnetic Flow Meter.
  - DD. Electric Meter: Digital Electric Meter with Modbus communication (Honeywell / E-Mon Class 3200 Smart Meter With MODBUS RTU communication, basis of design). Unit must display and communicate totalized kWh, voltage, amps, kW.
  - EE. Liquid Flow Meters: Onicon F-3500 Electromagnetic Flow Meter, D-100 Display with LonWorks Communication (other Onicon displays allowed with designer approval).
- 2.7 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW
- A. The BAS Contractor must provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server must communicate using Ethernet and TCP. Server must be accessed using a web browser over Owner intranet and remotely over the Internet.
  - B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) must be

browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.

- C. The BAS server software must support at least the following server platforms (Windows 7, 8.1, Server 12). The BAS server software must be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- D. The web browser GUI must provide a completely interactive user interface and must provide a HTML5 experience that supports the following features as a minimum:
  - 1. Trending.
  - 2. Scheduling.
  - 3. Electrical demand limiting.
  - 4. Duty Cycling.
  - 5. Downloading Memory to field devices.
  - 6. Real time 'live' Graphic Programs.
  - 7. Tree Navigation.
  - 8. Parameter change of properties.
  - 9. Set point adjustments.
  - 10. Alarm / event information.
  - 11. Configuration of operators.
  - 12. Execution of global commands.
  - 13. Add, delete, and modify graphics and displayed data.
- E. Software Components: All software must be the most current version. All software components of the BAS system software must be provided and installed as part of this project. BAS software components must include:
  - 1. Server Software, Database and Web Browser Graphical User Interface.
  - 2. 5 Year Software Maintenance license. Labor to implement not included.
  - 3. Embedded System Configuration Utilities for future modifications to the system and controllers.
  - 4. Embedded Graphical Programming Tools.
  - 5. Embedded Direct Digital Control software.
  - 6. Embedded Application Software.
- F. BAS Server Database: The BAS server software must utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
- G. Thin Client - Web Browser Based: The GUI must be thin client or browser based and must meet the following criteria:
  - 1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software must be required on the operator's GUI workstation/client. Connection must be over an intranet or the Internet.
  - 2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server must offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol must be Hyper-Text Transfer Protocol (HTTP).

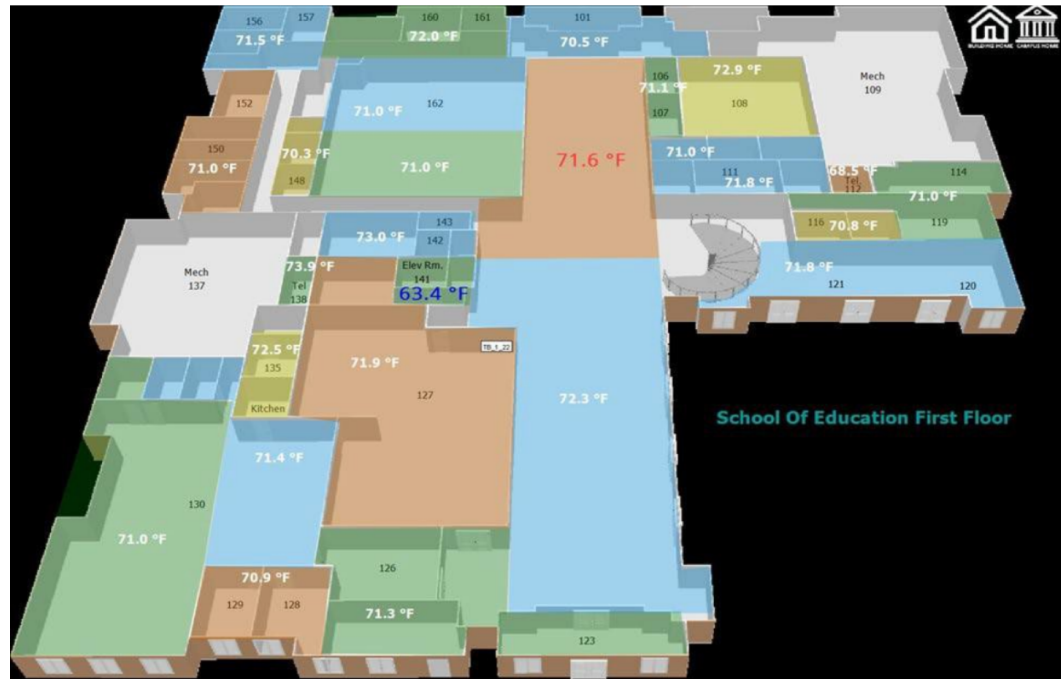
## 2.8 WEB BROWSER GRAPHICAL USER INTERFACE

- A. Web Browser Navigation: The Thin Client web browser GUI must provide a comprehensive user interface. Using a collection of web pages, it must be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It must be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI must (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.
- B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator must be presented with a login page that will require a login name and strong password. Navigation in the system must be dependent on the operator's role-based application control privileges.
- C. Navigation: Navigation through the GUI must be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane must be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree must as a minimum provide the following views: Geographic, Network, Groups and Configuration.
  - 1. Geographic View must display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
  - 2. Groups View must display Scheduled Groups and custom reports.
  - 3. Configuration View must display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).
- D. Action Pane: The Action Pane must provide several functional views for each subsystem specified. A functional view must be accessed by clicking on the corresponding button:
  - 1. Graphics: Using graphical format suitable for display in a web browser, graphics must include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page must automatically refresh.
  - 2. Dashboards: User customizable data using drag and drop HTML5 elements. Must include Web Charts, Gauges, and other custom developed widgets for web browser. User must have ability to save custom dashboards.
  - 3. Search: User must have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends must be available in result.
  - 4. Properties: Must include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages must require the operator to depress an 'accept/cancel' button.
  - 5. Schedules: Must be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
  - 6. Alarms: Must be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
  - 7. Charting: Must be used to display associated trend and historical data, modify colors, date range, axis and scaling. User must have ability to create HTML charts through web browser without utilizing chart builder. User must be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
  - 8. Logic - Live Graphic Programs: Must be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
  - 9. Other actions such as Print, Help, Command, and Logout must be available via a drop-



down window.

- E. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:
1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
  2. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
  3. Color Floor Plans: Floor plan graphics must show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors must be updated dynamically as a zone's actual comfort condition changes.
  4. Mechanical Components: Mechanical system graphics must show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment must be displayed with the appropriate engineering units. Animation must be used for rotation or moving mechanical components to enhance usability. .
  5. Minimum System Color Graphics: Color graphics must be selected and displayed via a web browser for the following:
    - a. Each piece of equipment monitored or controlled including each terminal unit.
    - b. Each building.
    - c. Each floor and zone controlled.
  6. Display Size : The GUI workstation software must graphically display in a minimum of 1024 by 728 pixels 24 bit True Color.
  7. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
  8. Color Floor Plans: Floor plan graphics must be multi-colored to differentiate between the different zones and areas. Colors selected are based on a neutral palette as to not show a large variance in bright colors but more of a neutral, slightly different tones. Provide a visual display of temperature relative to their respective set points via the use of a color changing font and size that displays the zone temperature. The displayed temperature must change to a red blinking, size 20 font for high space temperature and blue blinking, size 20 font for low space temperature. The colors and font size must be updated as a zone's actual comfort condition changes from a normal range to a high or low out of range measurement.



- F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) must be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree must be shown in a summary schedule table and graph.
1. Schedules: Schedules must comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and must allow events to be scheduled based on:
    - a. Types of schedule must be Normal, Holiday or Override.
    - b. A specific date.
    - c. A range of dates.
    - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
    - e. Wildcard (example, allow combinations like second Tuesday of every month).
  2. Schedule Categories: The system must allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories must include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
  3. Schedule Groups: In addition to hierarchical scheduling, operators must be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator must be able to define an 'individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' must automatically be downloaded to control modules affecting spaces occupied by the 'tenant group'.
  4. Intelligent Scheduling: The control system must be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If

- the operator schedules an individual room in a VAV system for occupancy, for example, the control logic must automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events must be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
  6. Schedule Summary Graph: The schedule summary graph must clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level must apply.
- G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, must be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions must have the following capabilities:
1. Alarms View: Each Alarm must display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link must indicate the system location, address and other pertinent information. An operator must easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
  2. Alarm Categories: The operator must be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon must be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
  3. Alarm Templates: Alarm template must define different types of alarms and their associated properties. As a minimum, properties must include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
  4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it must be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree must be used to setup Alarm Areas in the Graphic Pane.
  5. Alarm Time/Date Stamp: All events must be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
  6. Alarm Configuration: Operators must be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree must expose all objects and their respective Alarm Configuration. Configuration must include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
  7. Alarm Summary Counter: The view of Alarm in the Graphic Pane must provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
  8. Alarm Auto-Deletion: Alarms that are acknowledged and closed must be auto-deleted from the database and archived to a text file after an operator defined period.
  9. Alarm Reporting Actions: Alarm Reporting Actions specified must be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators must be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions must be as follows:
    - a. Print: Alarm information must be printed to the BAS server's PC or a networked printer.
    - b. Email: Email must be sent via any POP3-compatible e-mail server (most Internet

- Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action must also be used to support alphanumeric paging services, where email servers support pagers.
- c. File Write: The ASCII File write reporting action must enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file must be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
  - d. Write Property: The write property reporting action updates a property value in a hardware module.
  - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
  - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
- H. Trends: As system is engineered, all points must be enabled to trend. Trends must both be displayed and user configurable through the Web Browser GUI. Trends must comprise analog, digital or calculated points simultaneously. A trend log's properties must be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator must have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system must allow y- and x-axis maximum ranges to be specified and must be able to simultaneously graphically display multiple trends per graph.
  2. Local Trends: Trend data must be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date must be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
  3. Resolution. Sample intervals must be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
  4. Dynamic Update. Trends must be able to dynamically update at operator-defined intervals.
  5. Zoom/Pan. It must be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
  6. Numeric Value Display. It must be possible to pick any sample on a trend and have the numerical value displayed.
  7. Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
- I. Security Access: Systems that Security access from the web browser GUI to BAS server must require a Login Name and Strong Password. Access to different areas of the BAS system must be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles must reflect the actual roles of different types of operators. Each role must comprise a set of 'easily understood English language' privileges. Roles must be defined in terms of View, Edit and Function Privileges.
    - a. View Privileges must comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
    - b. Edit Privileges must comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
    - c. Function Privileges must comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual

Commands, Print and Alarm/Event Maintenance.

2. Geographic Assignment of Roles: Roles must be geographically assigned using a similar expandable/collapsible navigation tree. For example, it must be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

## 2.9 GRAPHICAL PROGRAMMING

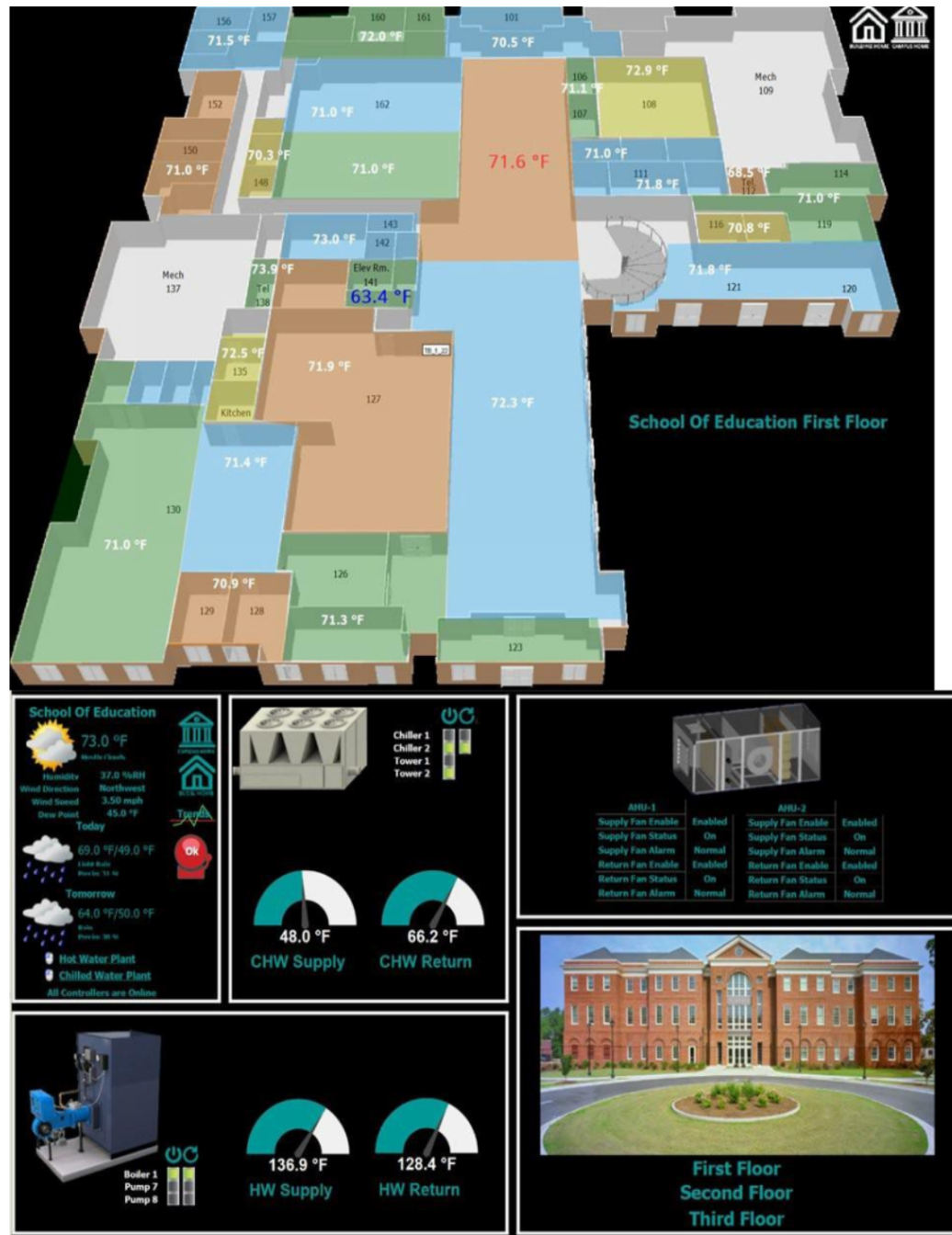
- A. The system software must include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming must not be accepted. All systems must use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock must be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming must be performed while on screen and using a mouse; each microblock must be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. Graphic Sequence: The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.
- D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
  1. Function Block (FB): Must be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
  2. Logical I/O: Input/Output points must interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
  3. Microblocks: Must be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks must be submitted with the control contractors bid.
  4. Wires: Must be Graphical elements used to form logical connections between microblocks and between logical I/O.
  5. Reference Labels: Labels must be similar to wires in that they are used to form logical connections between two points. Labels must form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
  6. Parameter: A parameter must be a value that may be tied to the input of a microblock.
  7. Properties: Dialog boxes must appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes must contain various editable and non-editable fields, and must contain 'push buttons' for the purpose of selecting

default parameter settings.

8. Icon: An icon must be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Must be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
10. Live Graphical Programs: The Graphic Programming software must support a 'live' mode, where all input/output data, calculated data and set points must be displayed in a 'live' real-time mode.

## 2.10 WEB BROWSER GRAPHICAL USER INTERFACE

- A. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:
  1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
  2. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
  3. Color Floor Plans: Floor plan graphics must be multi-colored to differentiate between the different zones and areas. Colors selected are based on a neutral palette as to not show a large variance in bright colors but more of a neutral, slightly different tones. Provide a visual display of temperature relative to their respective set points via the use of a color changing font and size that displays the zone temperature. The displayed temperature must change to a red blinking, size 20 font for high space temperature and blue blinking, size 20 font for low space temperature. The colors and font size must be updated as a zone's actual comfort condition changes from a normal range to a high or low out of range measurement.
  4. General Graphic: A general first page for the building must be of a standard summary format showing vital information and links to the building's operation and status. This PX page is named "overview" and is the first page to go to when accessing the building from the N4 Campus homepage.



## 2.11 LONWORKS NETWORK MANAGEMENT

- A. Systems requiring the use of third-party LonWorks network management tools must not be accepted.
- B. Network management must include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- C. The Network configuration tool must also provide diagnostics to identify devices on the network, to reset devices and to view health and status counters within devices.

- D. These tools must provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.
- E. The network management database must be resident in the Site Network Controller (SNC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times and within the control system must not be accepted.
- F. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:
  - 1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
  - 2. General Graphic: A general first page for the building must be of a standard summary format showing vital information and links to the building's operation and status. This PX page is named "overview" and is the first page to go to when accessing the building from the N4 Campus homepage.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.3 GENERAL

- A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams must be furnished and installed by the Control System Contractor in accordance with these specifications.
- C. Equipment furnished by the Mechanical Contractor that is normally wired before installation must be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.
- D. All control devices mounted on the face of control panels must be clearly identified as to function and system served with permanently engraved phenolic labels.

#### 3.4 WIRING



- A. All electrical control wiring to the control panels must be the responsibility of the Control System Contractor.
- B. All wiring must be in accordance with the Project Electrical Specifications (Division 16), the National Electrical Code and any applicable local codes. All control wiring must be installed in raceways.
- C. Excess wire must not be looped or coiled in the controller cabinet.
- D. Incorporate electrical noise suppression techniques in relay control circuits.
- E. There must be no drilling on the controller cabinet after the controls are mounted inside.
- F. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.
- G. Use manufacturer-specified wire for all network connections.
- H. Use approved optical isolation and lightning protection when penetrating building envelope.
- I. Read installation instructions carefully. Any unavoidable deviations must be approved by owner's rep prior to installation.

### 3.5 ACCEPTANCE TESTING

- A. Upon completion of the installation, the Control System Contractor must load all system software and start-up the system. The Control System Contractor must perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. The Control System Contractor must perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results. This testing must include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
- C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance must be contingent upon completion and review of all corrected deficiencies.

### 3.6 OPERATOR TRAINING

- A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor must provide on-site operator instruction to the owner's operating personnel. Operator instruction must be done during normal working hours and must be performed by a competent representative familiar with the system hardware, software and accessories.
- B. The Control System Contractor must provide eight (8) total hours of comprehensive training in multiple sessions for system orientation, product maintenance and troubleshooting, programming and engineering. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the last class is to be in the last month of 1-year warranty period.

### 3.7 WARRANTY PERIOD SERVICES

- A. Equipment, materials and workmanship incorporated into the work must be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship must be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.
- C. Maintenance of Computer Software Programs: The Control System Contractor must maintain all software during the standard first year warranty period. In addition, all factory or sub-vendor upgrades to software during the first-year warranty period must be added to the systems, when they become available, at no additional cost. In addition to first year standard warranty, software provided by Control System Contractor must come with a 1 Year Software Maintenance license. All SNC and BAS Servers are included in this coverage.
- D. Maintenance of Control Hardware: The Control System Contractor must inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor must then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report must clearly certify that all hardware is functioning correctly.
- E. Service Period: Calls for service by the Owner must be honored within 24 hours and are not to be considered as part of routine maintenance.
- F. Service Documentation: A copy of the service report associated with each owner-initiated service call must be provided to the owner.

### 3.8 WARRANTY ACCESS

- A. The Owner must grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

### 3.9 OPERATION & MAINTENANCE MANUALS

- A. See Division 1 for requirements. O&M manuals must include the following elements, as a minimum:
  - 1. As-built control drawings for all equipment.
  - 2. As-built Network Communications Diagram.
  - 3. General description and specifications for all components.
  - 4. Completed Performance Verification sheets.
  - 5. Completed Controller Checkout/Calibration Sheets.

### 3.10 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230900

## SECTION 232113 - HYDRONIC PIPING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:

1. Steel pipe and fittings.
2. PVC pipe and fittings.
3. Copper tube and fittings.
4. Joining materials.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
1. Hot-Water Heating Piping: 100 psig at 200 deg F.
  2. Air-Vent Piping: 200 deg F.

## 2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

- B. Copper or Bronze Pressure-Seal Fittings:
  - 1. Housing: Copper.
  - 2. O-Rings and Pipe Stops: EPDM.
  - 3. Tools: Manufacturer's special tools.
  - 4. Minimum 200-psig working-pressure rating at 250 deg F.
- C. Wrought-Copper Unions: ASME B16.22.

## 2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.

## 2.4 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. 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.

## 2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Description:
    - a. Standard: ASSE 1079.

- b. Pressure Rating: 125 psig minimum at 180 deg F.
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

### PART 3 - EXECUTION

#### 3.1 PIPING APPLICATIONS

- A. Chilled and Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- B. Chilled and Hot-water piping, aboveground, NPS 2-1/2 and greater, shall be the following: Schedule 40, Grade B steel pipe; Class 250, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- C. Condensate-Drain Piping, PVC: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- D. Air-Vent Piping:
  - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
  - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

#### 3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. 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.
- C. Install piping to permit valve servicing.
- D. Install piping at indicated slopes.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Install piping to allow application of insulation.
- H. Select system components with pressure rating equal to or greater than system operating pressure.

- I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- K. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. 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.
- N. Install valves according to the following:
  - 1. Section 230523.12 "Ball Valves for HVAC Piping."
  - 2. Section 230523.13 "Butterfly Valves for HVAC Piping."
  - 3. Section 230523.14 "Check Valves for HVAC Piping."
- O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

### 3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

### 3.4 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. 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. PVC Nonpressure Piping: Join according to ASTM D 2855.

- E. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting and coupling

### 3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  - 3. Isolate expansion tanks and determine that hydronic system is full of water.
  - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. 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."

5. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

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 232113



## SECTION 232116 - HYDRONIC PIPING SPECIALTIES

## 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. Hydronic specialty valves.
  - 2. Air-control devices.
  - 3. Strainers.
  - 4. Connectors.

- B. Related Requirements:

- 1. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
  - 2. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product:

- 1. Include construction details and material descriptions for hydronic piping specialties.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

## 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

- B. 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 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

### 2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

### 2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

## PART 3 - EXECUTION

## 3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. 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.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

## 3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

END OF SECTION 232116

## SECTION 232123 - HYDRONIC PUMPS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Wet-rotor pumps.

## 1.2 DEFINITIONS

- A. ECM: Electronically commutated motor.

## 1.3 ACTION SUBMITTALS

## A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.2 WET-ROTOR PUMPS

- A. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.
- B. Pump Construction:
  - 1. Body: Type 304 stainless steel.
  - 2. Impeller: Type 304 stainless steel.
  - 3. Pump Shaft: Type 304 stainless steel.
  - 4. Bearings. Double-sintered carbon.
- C. Motor: Variable speed.
  - 1. Integral pump motor variable-speed control.
  - 2. ECM.

## 2.3 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
  - 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
  - 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
  - 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
  - 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
  - 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
  - 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PUMP INSTALLATION

- A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

### 3.3 PIPING 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.

### 3.4 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
  - 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 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.

### 3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

## SECTION 233113 - METAL DUCTS

## 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. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

## B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

## 1.3 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.

## 1.4 ACTION SUBMITTALS

## A. Product Data: For each type of the following products:

1. Sealants and gaskets.

## B. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.2 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 Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 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.



## 2.3 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. Solvent-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Base: Synthetic rubber resin.
  - 3. Solvent: Toluene and heptane.
  - 4. Solids Content: Minimum 60 percent.
  - 5. Shore A Hardness: Minimum 60.
  - 6. Water resistant.
  - 7. Mold and mildew resistant.
  - 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  - 9. Service: Indoor or outdoor.
  - 10. Substrate: Compatible with galvanized sheet steel.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.4 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 Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 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 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. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. 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.
- J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

### 3.2 DUCT SEALING

- A. Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed:

### 3.3 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. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 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 a maximum interval of 16 feet.
  - 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.
- 3.4 CONNECTIONS
- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
  - B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.5 PAINTING
- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.
- 3.6 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
  - B. 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.
  - C. Duct system will be considered defective if it does not pass tests and inspections.
  - D. Prepare test and inspection reports.
- 3.7 START UP
- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel.
- B. Ducts:
  - 1. Ducts Connected to Variable-Air-Volume Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg.
    - b. SMACNA Leakage Class for Rectangular: 6.
    - c. SMACNA Leakage Class for Round: 3.
- C. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
- D. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 1000 fpm or Lower:
      - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.
    - b. Velocity 1000 to 1500 fpm:
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - 3) 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."
  - 2. 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."

END OF SECTION 233113

## SECTION 233300 - AIR DUCT ACCESSORIES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

## A. Section Includes:

- 1. Turning vanes.
- 2. Duct accessory hardware.

## B. Related Section Includes:

- 1. Section 283111 - Fire Detection and Alarm System for duct-mounted fire and smoke detectors.

## 1.3 ACTION SUBMITTALS

## A. Product Data: For each type of product.

- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

## 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## 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.

## 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 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 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Vane Construction: Single wall.

## 2.4 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 ducts.
- C. Install test holes at fan inlets and outlets and elsewhere as indicated.
- D. Install duct test holes where required for testing and balancing purposes.

## 3.2 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 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.

END OF SECTION 233300

## SECTION 233723 - HVAC GRAVITY VENTILATORS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Hooded ventilators.

## 1.2 ACTION SUBMITTALS

## A. Product Data: For each type of product

## B. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

## 1.3 COORDINATION

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

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads, Basis: Determine loads based on 146 mph.

- B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.



## 2.2 FABRICATION

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

## 2.3 HOODED VENTILATORS

- A. Description: Hooded rectangular penthouse.
- B. Provide counter-weighted backdraft dampers. TAMCO Series 7000 CW medium-duty adjustable counterweighted backdraft damper with salt water resistance option or approved equal.
- C. Source Limitations: Obtain hooded ventilators from single manufacturer.

## 2.4 SOURCE QUALITY CONTROL

- A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

## 2.5 MATERIALS

- A. Fasteners: 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
  - 1. Use types and sizes to suit unit installation conditions.
  - 2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

- B. Secure gravity ventilators to roof curbs with stainless steel hardware, that comply with the wind fastening requirements. Use concealed anchorages where possible.
- C. Install gravity ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses.
- F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

### 3.2 DUCT CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

### 3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

## SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components, including the following:
  - 1. Casings.
  - 2. Fans, drives, and motors.
  - 3. Coils.
  - 4. Air filtration.
  - 5. Dampers.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include unit dimensions and weight.
  - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
  - 5. Fans:
    - a. Include certified fan-performance curves with system operating conditions indicated.
    - b. Include certified fan-sound power ratings.
    - c. Include fan construction and accessories.
    - d. Include motor ratings, electrical characteristics, and motor accessories.
  - 6. Include certified coil-performance ratings with system operating conditions indicated.
  - 7. Include filters with performance characteristics.
  - 8. Include dampers, including housings, linkages, and operators.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.
  - 1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
  4. Include diagrams for power, signal, and control wiring.
- D. Delegated Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for selecting vibration isolators.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Startup service reports.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Filters: Three set(s) for each air-handling unit.
  2. Gaskets: One set(s) for each access door.

#### 1.7 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: 1 year(s) from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

## 2.2 GENERAL

- A. Unit layout and configuration shall be as defined in project plans and schedule.
- B. Manufacturer to provide a full perimeter integral base frame to support and raise all sections of the unit for proper trapping. Base frame will either be bolted construction or welded construction. Refer to schedule for base height and construction type. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in total height required for proper trap height.

## 2.3 UNIT CASING

- A. Unit manufacturer shall ship unit in segments for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
- B. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft<sup>2</sup> of casing surface area) = CL X P<sup>0.65</sup>.
- C. Casing performance - Casing air leakage shall not exceed 1% of design airflow at the specified casing pressure.
- D. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- E. Air leakage shall be determined at a casing static pressure of 6 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- F. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).
- G. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.
- H. Unit casing panels shall be double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- I. Unit casing panels (roof, walls,) and doors shall be provided with a minimum thermal resistance (R-value) scheduled. Units provided with R19 thermal performance shall include double-thermal break design on casing roof and walls.

- J. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- K. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- L. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- M. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.
- N. Traction enhancements shall be applied to the unit floor to improve the walking surface in those unit sections where the floor is fully accessible, and not impeded by internal structural or functional features.

## 2.5 ACCESS DOORS

- A. Access door construction shall be same as main unit casing, including R value. All doors shall be provided with a thermal break construction of the door panel and frame. Full perimeter gasketing of the door shall be provided to prevent air leakage. Doors shall be provided with stainless steel hinges. Handle hardware shall be designed such as to prevent unintended closure. Doors shall be minimum 60-inches in height when sufficient unit height is available. If not available, door height shall be height of unit. Single handle door shall be provided for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit.
- B. Access Door: Door hardware shall be surface-mounted. Access doors shall be hinged and removable without the use of specialized tools. Hinges and handles shall be interchangeable to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions. Door handle hardware shall be adjustable and visually indicate locking position of the door latch external to the section.
- C. Test ports shall be supplied in access doors as defined in the unit schedule to facilitate the field commissioning by the test and balance contractor. Test ports shall not compromise the ASHRAE leakage class of the unit.

## 2.6 PRIMARY DRAIN PANS

- A. All cooling coil sections shall be provided with an insulated, double-wall, galvanized drain pan.
- B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. See section 2.07, paragraph F through H for specifications on intermediate drain pans between cooling coils.

- C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
- E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
- F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
- G. It is recommended that coil support members, drain pan, and coil casing shall be of the same material.
- H. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

## 2.7 FANS

- A. Access to fan shall be through a hinged and latched access door on the drive side of the unit to allow inspection and maintenance of the fan, and motor. Construct door(s) per Section 2.04.
- B. Provide fans of type and class as specified on the schedule. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. All fans shall be capable of operating in a VAV system throughout the fans operating range without a resonance frequency issue. Fans operated with a frequency drive shall not have lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans operating on a frequency inverter shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.
- C. Fans with integral frame motors, shall be <<FAN\_ISOLATION>>. Fans selected with isolation shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- D. Direct drive plenum fans provided with ECM motors shall be balanced to a G6.3 per AMCA 204. No vibration isolation base required for these type fans. Motors for these fan types shall included an integral PID controller that will accept a 0-10VDC input signal for variable speed control.

- E. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.
- F. Each direct drive fan in a multiple-fan array shall be provided with integral back flow prevention: a backdraft damper that prohibits recirculation of air in the event a fan or multiple fans become disabled. Dampers are tested and rated based on AMCA Standard 500. Dampers to be heavy duty type capable of a maximum back pressure that exceeds the design total static pressure with minimal leakage. The dampers should have a minimal total effect on airflow performance, both pressure drop when open and system effect on the fan. The damper blades and frame shall be extruded aluminum with blade edge seals locked into the blade edge. Adhesive type seals are unacceptable. AHU manufacturer responsible for providing proper spacing upstream of dampers to ensure full, uniform airflow through upstream components. For units where the damper(s) are supplied at the jobsite, the installing contractor shall contract a certified TAB contractor to verify uniform airflow thru upstream components.
- G. MOTORS AND DRIVES
  - 1. Integral frame motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
  - 2. Integral frame fan Motors shall be heavy duty, open drip-proof operable at 460 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.
  - 3. Direct driven fans utilizing integral frame motors shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
  - 4. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
  - 5. Manufacturer shall provide flexible, steel conduit to completely cover high voltage wiring from integral horsepower fan motors, to the raceway, VFD, junction box, overload box or motor control panel.
  - 6. Manufacturer shall provide integral motor rail for attachment of a field provided hoist capable of lifting the maximum motor weight. Rail should extend the full width of the unit and be positioned so that motor(s) can be removed through the fan access door.

## 2.8 COILS

- A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.



- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- D. Construct coil casings of galvanized steel steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
- F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.
- G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- I. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117.
- J. Hydronic Coils
  - 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
  - 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
  - 3. Headers shall be constructed of round copper pipe or cast iron.
  - 4. Tubes shall be 1/2-inch .016 copper, with aluminum fins.

5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

## 2.9 FILTERS

- K. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall be provided with front loading filter frames. Filter holding frames shall be constructed of galvanized steel and equipped with foam gaskets to seal filters against filter frames. Frame seams shall be sealed to eliminate air bypass. Access door(s) shall be provided to facilitate filter removal. Construct doors in accordance with Section 2.04. Manufacturer to provide necessary filter clips to lock primary and secondary prefilters (if ordered) tightly to filter frame without the need for special tools, bolts or nuts. Filter holding frames shall be of a universal type to accommodate standard filters of 12x24 and 24x24 nominal size as well as appropriate fasteners.
- L. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule.
- M. Manufacturer shall provide one set of startup filters.
- N. Each filter section shall be provided with a factory-installed, flush-mounted Dwyer dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F. Filter sections consisting of pre- and post-filters shall have a gauge for each.

## 2.10 DAMPERS

- A. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

## 2.11 ACCESS SECTIONS

- A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual. Access section doors shall be constructed per Section 2.04.

## 2.15 MARINE LIGHTS

- A. Marine lights shall be provided throughout AHUs as indicated on the schedule and plans. Lights shall be instant-on, light-emitting diode (LED) type to minimize amperage draw and shall produce lumens equivalent to a minimum 75W incandescent bulb (1200 lumens). LED lighting shall provide instant-on, white light and have a minimum 50,000 hr. life.
- B. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion.
- C. Fixtures shall be designed for flexible positioning during maintenance and service activities for best possible location providing full light on work surface of interest and not being blocked by technician.
- D. All lights on a unit shall be wired in the factory to a single on-off switch.
- E. Installing contractor shall be responsible for providing 115V supply to the factory-mounted marine light circuit (unless single-point power is specified to be provided by AHU manufacturer).

#### 2.16 CONVENIENCE OUTLETS

- A. A 15-amp, 115V GFCI convenience outlet shall be provided by the AHU manufacturer. The outlet shall be separate from the load side of the equipment per NEC requirements. Installing contractor shall be responsible for providing 115V supply to the factory-mounted GFCI outlet circuit per NEC (even when single-point power is specified to be provided by AHU manufacturer).

#### 2.23 MOTOR OVERLOAD PANEL FOR FAN ARRAYS

- A. A motor overload panel provides a single unit mounted UL508A listed control panel with all fans in an array pre-wired to it, such that one properly sized VFD may be field connected with no additional provisions required for protection of the individual motors. The control panel enclosure will be mounted on the exterior of the fan section and will be NEMA type 1 for indoor units and NEMA type 4 for outdoor units. A single power distribution block shall be provided for connection of the field mounted VFD with one conductor per phase. An electronic motor overload protector with lockable manual isolation switch shall be provided for each motor in the array. Each motor in the array shall be independently grounded with a dedicated green conductor. A minimum of one open ground lug per fan plus one shall be provided for field use. Each motor overload protector shall be provided with an auxiliary contact and all auxiliary contacts will be wired in series to a terminal block for generic trip signaling. The panel will be rated for WYE power systems up to 600V.

#### 2.24 Factory Testing

- A. A factory air leakage test shall be performed to verify the air handling unit conforms to the specified air leakage requirement. The entire unit shall be tested at specified total unit static as selected and specified from the TOPSS selection. Leakage shall be calculated by totaling all leakage either into or out of the unit casing. Leakage shall not exceed specified leakage amount. Air pressure and casing leakage shall be measured by a third party calibrated and

certified apparatus. A written test report shall be prepared by the manufacturer and issued to the owner or owner representative.

- B. A factory unit deflection test shall be performed to verify the air handling unit does not exceed  $L/240$  of the panel span at the specified total unit static as selected and specified from the TOPSS selection. A written test report shall be prepared by the manufacturer and issued to the owner or owner representative.
- C. The owner or designated representative shall witness the leakage and/or deflection test(s) at the factory. The owner will be notified a minimum of 10 days in advance of the testing to provide time to coordinate travel arrangements. Written test report(s) shall be prepared by the manufacturer and issued and presented to the owner or owner representative after testing.

### PART 3 - EXECUTION

#### 3.1 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 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.

#### 3.2 INSTALLATION, GENERAL

- A. Equipment Mounting:
  - 1. Install air-handling units on concrete floor.
- 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-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using PVC piping. Extend to nearest floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

### 3.4 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

### 3.5 CONTROL CONNECTIONS

- A. DDC contractor is responsible for installing all control components identified on the drawings and BMS specification.
- B. Install control and electrical power wiring to field-mounted control devices.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup check according to manufacturer's written instructions.
  - 2. Verify that shipping, blocking, and bracing are removed.
  - 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 zone dampers fully open and close for each zone.
  - 7. Verify that face-and-bypass dampers provide full face flow.
  - 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
  - 9. Comb coil fins for parallel orientation.
  - 10. Verify that proper thermal-overload protection is installed for electric coils.
  - 11. Install new, clean filters.

12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
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 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 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 internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
  2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

- E. Prepare test and inspection reports.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.16

## SECTION 260500 - GENERAL ELECTRICAL

## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. The Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 bound herewith are a component part of this Division of the specifications and shall apply to this Division with equal force and shall be consulted in detail for instructions pertaining to the work.
- B. Furnish all labor, materials and equipment and incidentals required to make ready for use complete electrical systems as shown on the Drawings and specified herein.
- C. It is the intent of these Specifications that the electrical systems shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.
- D. The work shall include, but not be limited to, furnishing, coordinating, and installing the following:
  - 1. Electrical distribution system for power, and miscellaneous power as shown on the contract drawings.
  - 2. Grounding.
  - 3. Other special requirements and/or systems where shown.
- E. Each bidder (or Representative) shall, before preparing a proposal, visit all areas of the existing site. If the work includes demolition, restoration, renovation and/or addition; then existing buildings and structures should be carefully inspected. The submission of the proposal by this Bidder shall be considered evidence that the Bidder (or Representative) has visited the site and noted the locations and conditions under which the work will be performed and that the Bidder takes full responsibility for a complete knowledge of all factors governing the work.
- F. All power interruptions to existing equipment shall be at the Owner's convenience with 24 hours (minimum) notice. Each interruption shall have prior approval.
- G. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All work shall be of the highest quality; substandard work will be rejected.
- H. Field verify all existing underground electrical and mechanical piping.

## 1.2 SUBMITTALS



- A. Shop drawings shall be submitted for all equipment, apparatus, and other items as required by the Architect/Engineer. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.
- B. Submittals are required for all materials shown in the individual specifications sections.
- C. Submittals are required for materials and specific methods used for penetrations of rated assemblies and for seismic restraints.
- D. All shop drawings and submittals shall be submitted at the same time. Partial shop drawing and submittals will be rejected and not processed. Materials, equipment and long lead items that require special handling, if identified and requested by the contractor, will be processed separately.
- E. Proposed equipment and/or materials substitutions shall be clearly indicated in shop drawings. All deviations from the specified quality, functionality, appearance or performance of the proposed equipment and/or materials shall be clearly summarized in the preface of each submittal.
- F. The project shall be bid based on the equipment listed in these specifications and on the drawings. After award of the Electrical Contract the Contractor may wish to substitute equipment other than that specified, subject to approval. The Electrical Contractor shall bear the "burden of proof" for demonstrating substitute equipment equivalency and suitability.
- G. The Electrical Contractor shall be required to replace installed "equivalent" equipment if the operation of this equipment does not meet the full design intent of the specified system.
- H. Physical size of equipment used in the design layout are those of reputable equipment manufacturers. The Contractor is responsible for providing equipment which will fit the space provided. If the Contractor elects to use other manufacturer's equipment, any resulting conflicts with space clearance or codes shall be the responsibility of the Contractor to correct at the Contractor's expense.
- I. The Contractor assumes all responsibility for providing code clearances. Submit a scale drawing of each electrical equipment room showing exact size and location of all proposed electrical equipment with code clearances and working space clearly indicated.

### 1.3 COORDINATION OF WORK

- A. It is understood and agreed that the Contractor is, by careful examination, satisfied as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can and may affect the work under this contract. The Contractor shall be held responsible for visiting the site and thoroughly familiarizing himself with the existing conditions and also any contractual requirements as may be set forth in the other Divisions of these Specifications. No extras will be considered because of additional work necessitated by obvious job conditions that are not indicated on the drawings.
- B. The Contractor shall compare the electrical drawings and specifications with the drawings and specifications for other trades, and shall report any discrepancies between them to the

Architect/Engineer and obtain written instructions for changes necessary in the electrical work. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by neglect to do so shall be made at the expense of the Contractor.

- C. Location of electrical raceways, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The Contractor shall determine the exact route and location of each electrical raceway prior to make up and assembly.
  - 1. Right of Way: Lines which pitch shall have the right of way over those which do not pitch. For example, steam, condensate and plumbing drains shall normally have right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
  - 2. Offsets and changes in direction of electrical raceways shall be made as required to maintain proper headroom and to clear pitched lines whether or not indicated on the drawings. The Contractor shall furnish and install elbows, pull boxes, etc., as required to affect these offsets, transitions, and changes in directions. Conflicts between electrical raceways, fixtures, etc., and ductwork or piping which cannot be resolved otherwise, will be resolved by the Architect/Engineer.
- D. Installation and Arrangements: The Contractor shall install all electrical work to permit removal (without damage to other parts) of any equipment requiring periodic replacement or maintenance. The Contractor shall arrange electrical raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging and overhead doors and of access panels.

#### 1.4 EQUIPMENT AND MATERIALS (GENERAL)

- A. In compliance with North Carolina General Statute 133.3, the Architect/Engineer has, wherever possible, specified the required performance and design characteristics of all materials utilized in this construction. In some cases, it is impossible to specify the required performance and design characteristics and when this occurs the Architect/Engineer has specified three or more examples of equal design or equivalent design, establishing an acceptable range for items of equal or equivalent design. Cited examples are used only to denote the quality standard of product desired and do not restrict bidders to a specific brand, make, manufacturer or specific name and are used only to set forth and convey to bidders the general style, type, character and quality of product desired. Equivalent products will be acceptable.
- B. Substitution of materials, items, or equipment of equal or equivalent design shall be submitted to the Architect/Engineer for approval or disapproval. Equal or equivalent shall be interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use and capable of performing the same functions as that named, the Architect/Engineer being the judge of equality.
- C. The materials used in all systems shall be new, unused and as hereinafter specified and shall bear the manufacturer's name, trade name and third party testing agency label in every case where a standard has been established for the particular material. Equipment furnished under this specification shall be essentially the standard product of manufacturers regularly engaged

in the production of the required type of equipment, and shall be the manufacturer's latest approved design. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval as required by the Architect/Engineer.

- D. Protection: Electrical equipment shall at all times during construction be adequately protected against damage. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury and theft. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry, permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner. At the completion of the work, fixtures, equipment, and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect/Engineer. Damage or defects, developing before acceptance of the work shall be made good at the Contractor's expense.
- E. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting specifications in Division 9, at no additional cost to the Owner.
- F. Where materials such as wiring devices and plates, fire alarm equipment, paging system components, etc. are specified to match existing, provide materials to match existing equipment in finish, color, capacity, ratings, operating characteristics, performance, etc.
- G. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect/Engineer until installed.
- H. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.
- I. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflicts between any requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect/Engineer's written instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's direction or such written instructions from the Architect/Engineer, the Contractor shall bear all costs arising in correcting the deficiencies.

#### 1.5 OPERATION AND MAINTENANCE MANUALS

- A. Submit under relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.
- B. The Contractor shall provide two compilations of catalog data, bound in suitable loose leaf binders, for each manufactured item of equipment used in the electrical work. These shall be presented to the Architect/Engineer for transmittal to the Owner before the final inspection is made. Data shall include printed installation, operation and maintenance instructions for each item, indexed by product with heavy sheet dividers and tabs. All warranties shall be included

with each item. Each manufacturer's name, address and telephone number shall be clearly indicated.

- C. Shop drawings with Architect/Engineer's "as noted" markings are not acceptable for the above. "Approved" shop drawings are acceptable if adequate information is contained therein. Generally, shop drawings alone are not adequate.

#### 1.6 PAINTING

- A. All painting will be performed by the General Contractor for the project, unless specifically indicated otherwise.
- B. The Electrical Contractor shall clean all exposed electrical work for painting. Should the Electrical Contractor delay in installing exposed conduit and outlets until the General Contractor has begun painting, the Electrical Contractor shall be required to paint all exposed electrical work at the Electrical Contractor's own expense. Such painting will be accomplished in accordance with the detailed specifications for the Project.
- C. Conductors exposed in boxes and cabinets shall be protected against painting. Devices, cover plates, trims, etc., for panelboards and cabinets shall not be installed until painting has been completed.
- D. The Electrical Contractor shall be responsible for touch up painting that may be required for electrical material or apparatus furnished with factory applied finish.

#### 1.7 LOCATIONS AND MEASUREMENTS

Outlets and appliances are shown and located on the drawings as accurately as possible. All measurements shall be verified on the project and in all cases the work shall suit the surrounding trim, finishes and/or construction. The locations of outlets for special appliances shall be installed so that when extended, they are flush with the finished wall or ceiling and permit the proper installation of fixtures and/or devices. Heights of all outlets shown on the drawings are approximate only. Slight relocations of outlets, devices and equipment shall be made by the Contractor as required or as directed by the Architect/Engineer at no additional cost to the Owner.

#### 1.8 QUALITY OF WORK

All work shall be executed as required by this specification and the accompanying drawings and shall be done by skilled mechanics, and shall present a neat, trim, and mechanical appearance when completed. All work shall be performed as required by the progress of the job.

#### 1.9 SUPERVISION

- A. The Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from the beginning to completion and final acceptance. So far as possible, the Contractor shall keep the same foreman and mechanics throughout the project duration.

- B. During the progress of the work it shall be subject to inspection by representatives of the Architect/Engineer, the Owner, and local inspection authorities, at which time the Contractor shall furnish such required information and data on the project as requested.
- C. The Electrical Contractor shall coordinate the electrical work with other Contractors and cooperate in the preparation and maintenance of a master schedule for the completion of the project.

#### 1.10 CLOSING IN WORK

Work shall not be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over this work. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall uncover the work at the Contractor's expense; after it has been inspected, tested and approved, the Contractor shall restore the work to its original condition. The State Electrical Inspector at the State Construction Office shall be called for all inspections at 919-807-4111. Inspections shall be limited to Monday thru Friday unless specifically authorized by State Construction Office

#### 1.11 REFERENCE STANDARDS

- A. All electrical equipment, materials, and installation shall be in accordance with the latest edition of the following codes and standards:
  - 1. American Association of Edison Illuminating Companies (AEIC)
  - 2. American National Standards Institute (ANSI)
  - 3. American Society for Testing and Materials (ASTM)
  - 4. Building Officials Code Administrators (BOCA)
  - 5. Institute of Electrical and Electronic Engineers (IEEE)
  - 6. Insulated Cable Engineers Association (ICEA)
  - 7. International Code Council (ICC)
  - 8. International Conference of Building Officials (ICBO)
  - 9. National Electrical Code (NEC) 2017 edition
  - 10. National Electrical Contractor's Association (NECA)
  - 11. National Electrical Installation Standards (NEIS)
  - 12. National Electrical Manufacturer's Association (NEMA)
  - 13. National Electrical Safety Code (NESC)
  - 14. National Fire Protection Association (NFPA)
  - 15. North Carolina Energy Conservation Code, 2018 (NCECC)
  - 16. North Carolina State Building Code (NCSBC)
  - 17. North Carolina Construction Manual with GS as listed (NCCM)
  - 18. Occupational Safety and Health Act (OSHA)
  - 19. Requirements of the Americans with Disabilities Act (ADA), latest edition.
  - 20. Underwriters Laboratories Inc (U.L.)
  - 21. Southern Building Code Congress International (SBCCI)
  - 22. Toxicity Characteristics Leaching Procedure (TCLP)
- B. All electrical equipment and material shall be listed by an approved third party testing agency approved by the NCBCC and shall bear the appropriate testing agency's listing mark or

classification marking. Equipment, materials, etc. utilized not bearing a third party testing agency certification shall be field or factory third party testing agency certified prior to equipment acceptance and use.

- C. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

#### 1.12 ENCLOSURE TYPES

Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, indoor locations.
2. NEMA 3R for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" locations.
3. NEMA 4X for locations subject to corrosion when specifically noted.

#### 1.13 CORROSION PROTECTION

All equipment and hardware subject to exposure to the elements and/or not installed in a conditioned space shall be fabricated of non-metallic materials, hot dip galvanized after fabrication or stainless steel. The requirements of preceding section entitled "Delivery and Storage" shall be strictly followed. Touch up any scratched metallic surfaces immediately to prevent corrosion. Apply cold galvanizing compound to all galvanized surfaces damaged during installation, i.e., cutting, etc. Ferrous, rusted or corroded materials shall be replaced before final acceptance of the work.

#### 1.14 CODES, INSPECTION AND FEES

- A. All equipment, materials and installation shall be in accordance with the requirements of the local authority having jurisdiction which is the State Construction Office.
- B. The Electrical Contractor shall obtain all necessary permits and inspections of electrical work.
- C. The Electrical Contractor shall contact State Construction Office Electrical to schedule any and all required inspections. All inspections shall be limited to Monday thru Friday unless specifically authorized by the State Construction Office.

#### 1.15 TESTS AND SETTINGS

- A. Test all systems furnished under Division 26 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.
- B. Make the following minimum tests and checks prior to energizing electrical equipment:
  1. Mechanical inspection, testing and settings of all circuit breakers, disconnect switches, motor starters, control equipment, etc., for proper operation.
  2. Check all wire and cable terminations. Verify to the Architect/Engineer that connections meet the equipment torque requirements.

3. Check rotation of motors, obtain permission from other contractors to start motor, and proceed to check for proper rotation. If the motor rotates in the wrong direction, correct it. Take all necessary precautions not to damage any equipment.
  4. Provide all instruments and equipment for the tests specified herein.
- C. All testing shall be scheduled and coordinated by the Contractor. Notify the Owner at least two (2) weeks in advance of conducting tests. The Contractor shall have qualified personnel present during all testing.
- D. All tests shall be completely documented with the time of day, date, temperature, and all other pertinent test information. All required documentation of readings indicated shall be submitted to the Architect/Engineer prior to, and as one of the prerequisites for, final acceptance of the project.
- E. Electrical Distribution System Tests: All current carrying phase conductors and neutrals shall be tested as installed, and before load connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt megger. The following procedures shall be as follows:
1. Minimum readings shall be one million (1,000,000) ohms or more for #6 AWG wire and smaller; 250,000 ohms or more for #4 AWG wire or larger. Measurement to be taken between conductors and between conductor and the grounded metal raceway.
  2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. The Contractor shall then test each one separately to the panel until the low reading ones are found. The Contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
  3. The Contractor shall send a letter to the Architect/Engineer, and to the North Carolina State Construction Office certifying that the above has been done and tabulating the megger readings for each panel. This shall be done at least four (4) days prior to final inspection.
  4. At inspection, the Contractor shall furnish a megger and show Architect/Engineer's representative that the panels comply with the above requirements. The Contractor shall also furnish a clamp type ammeter and a voltmeter and take current and voltage readings as directed by the representatives.
  5. At inspection, the Contractor shall furnish ladders, required tools, and mechanics to open fixtures, boxes, panels, or any other equipment to enable the Architect/Engineer's representatives to see into any parts of the installation that may be requested.
- F. Electrical Grounding System Tests: Provide documentation showing values of earth ground impedance for the system ground. See Specifications Section 260526 for testing requirements.

#### 1.16 SLEEVES AND FORMS FOR OPENINGS

- A. Anchor bolts, sleeves, inserts, supports, etc., that may be required for electrical work shall be furnished, located and installed by the Electrical Contractor. The Electrical Contractor shall give sufficient information (marked and located) to the General Contractor in time for proper

placement in the construction schedule. Should the Electrical Contractor delay or fail to provide sufficient information in time, then the Electrical Contractor shall cut and patch construction as necessary and required to install electrical work. Such cutting and patching will be done by the General Contractor but paid for by the Electrical Contractor.

- B. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- C. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, request shop drawings, equipment location drawings, foundation drawings, and any other data required to locate the concealed conduit before the floor slab is poured.
- D. Where such data is not available in time to avoid delay in scheduled floor slab pours, the Architect/Engineer may elect to allow the installations of such conduits to be exposed. No additional compensation for such change will be allowed and written approval must be obtained from the Architect/Engineer.
- E. Seal all openings, sleeves, penetration, and slots as specified and as shown on the Contract Drawings.

#### 1.17 CUTTING AND PATCHING

- A. For the purposes of the Electrical Contract, “cutting and patching” shall be defined as that work required to introduce new electrical work into existing construction. Work required to install or fit electrical boxes, conduit, enclosures, equipment, etc. into new construction is not “cutting and patching”.
- B. The Electrical Contractor shall perform all cutting and patching necessary to install all equipment as required under his contract and shall re-establish all finishes to their original condition where cutting and patching occur.
- C. All cutting and patching shall be done in a thoroughly workmanlike manner.
- D. Core drill holes in existing concrete floors and walls as required.
- E. Install work at such time as to require the minimum amount of cutting and patching.
- F. Do not cut joists, beams, girders, columns or any other structural members without first obtaining written permission from the Architect/Engineer.
- G. Cut opening only large enough to allow easy installation of the conduit.
- H. Patching is to be of the same kind of material as was removed.
- I. The completed patching work shall restore the surface to its original appearance.
- J. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- K. Remove rubble and excess patching materials from the premises.



- L. Raceways and ducts penetrating rated floor, ceiling or wall assemblies shall be properly sealed in accordance with the corresponding Underwriters Laboratories approved method utilizing approved and listed materials.

#### 1.18 INTERPRETATION OF DRAWINGS

- A. The Electrical drawings and specifications are complementary each to the other and what may be called for by one shall be as binding as if called for by both. The drawings are diagrammatic and indicate generally the location of outlets, devices, equipment, wiring, etc. Drawings shall be followed as closely as possible; however, all work shall suit the finished surroundings and/or trim.
- B. Do not scale electrical drawings. Refer to the architectural drawings for dimensions.
- C. Where the words “furnish and install” or “provide” are used, it is intended that this contractor shall purchase and install completely any and/or all material necessary and required for this particular item, system, equipment, etc.
- D. Where the words “the Contractor” or “this Contractor” appear in either the Electrical Drawings or Division 26 Specifications, it shall mean the Electrical Contractor.
- E. Any omission from either the drawings or these specifications are unintentional, and it shall be the responsibility of this Contractor to call to the attention of the Architect/Engineer any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.
- F. Where no specific material or equipment type is mentioned, a high-quality product of a reputable manufacturer may be used provided it conforms to the requirements of these specifications. These materials shall be listed or labeled by a Third-Party Testing Agency accredited by the NCBCC to label electrical equipment.
- G. The electrical drawings show the general arrangement of raceways, equipment, fixtures, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Some adjustment of routings and installation of conduit, cable tray and devices should be expected. The electrical work shall conform to the requirements shown on all of the drawings. General and Structural drawings shall take precedence over Electrical Drawings. Because of small scale of the electrical drawings, it is not possible to indicate offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet such conditions, without additional cost to the Owner and as directed by the Architect/Engineer.
- H. Each 3-phase circuit shall be run in a separate conduit unless otherwise shown on the Drawings.
- I. Unless otherwise approved by the Architect/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- J. Where circuits are shown as “home runs” all necessary fittings and boxes shall be provided for a complete raceway installation.

- K. Verify with the Architect/Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- L. Any work installed contrary to or without approval by the Architect/Engineer shall be subject to change as directed by the Architect/Engineer, and no extra compensation will be allowed for making these changes.
- M. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Architect/Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Architect/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- N. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
- O. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of equipment.
- P. All connections to the equipment shall be made as required, and in accordance with the approved shop and setting drawings.
- Q. Redesign of electrical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at the Contractor's expense. Redesign and detailed plans shall be submitted to the Architect/Engineer for approval. No additional compensation will be provided for changes in the work, either the Electrical Contractor's or others, caused by such redesign.
- R. All floor mounted electrical equipment shall be placed on 4-inch thick concrete housekeeping pads. Edges shall be chamfered.

#### 1.19 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his materials in sections sized to permit passing through such restricted areas in the structure.
- B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to suitably brace the equipment, to ensure that the tilting does not impair the functional integrity of the equipment.

#### 1.20 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on one set of project contract drawings, herein after called the "record drawings".

- B. Record drawings shall accurately show the installed condition of the following items:
1. Panel schedule(s).
  2. Control wiring diagram(s).
  3. Lighting fixture schedule(s).
  4. Branch circuit conduit and conductor sizes.
  5. Lighting fixture, receptacle, and switch outlets, interconnections and homeruns with circuit identification.

#### 1.21 SEISMIC REQUIREMENTS

- A. All equipment furnished under the electrical contract shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code (NCSBC). The Contractor shall provide any and all seismic restraint details and calculations that may be required by the NCSBC and/or the Authority Having Jurisdiction.
- B. Requirements for restraints are detailed in the NCSBC. All tables and references shall conform to building's location. Restraints shall be per Seismic Performance Category stated on Architectural Drawings and Structural Drawings.
- C. The Contractor shall retain the services of a Professional Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The Engineer's calculations, bearing his professional seal, shall accompany shop drawings and shall demonstrate Code compliance including certification that the seismic system components comply with the testing requirements of NCSBC Section 1708.5. Calculations and shop drawings shall be submitted for review prior to the purchasing of materials, equipment, systems and assemblies. Internal seismic restraint elements of manufactured equipment shall be certified by a professional engineer retained by the manufacturer. Such certificate applies only to internal elements of the equipment. All equipment anchorage requirements shall be coordinated with the building structure and shall be compatible thereto. All such anchorages shall be subject to the review and approval of the project's structural engineer.
- D. The Professional Engineer retained for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation to comply with the Special Inspections requirement of the Code. This engineer shall provide written verification of compliance of the installation with the approved seismic submittal. This verification shall be submitted as a Special Inspections Report and shall bear the Engineer's professional seal. Job site inspections by other than this engineer are not acceptable.
- E. Review of the seismic design computations and shop drawings by the Architect/Engineer or his agent shall not relieve the Contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code.

#### 1.22 GUARANTEE

The Contractor shall guarantee the materials and workmanship covered by these drawings and specifications for a period of one year from the date of acceptance by the Owner. The Contractor shall repair and/or replace any parts of any system that may prove to be defective at

no additional cost to the Owner within the guarantee period. All equipment warranties shall be as specified and included in the Contract Documents.

1.23 PHASING OF THE WORK

The Electrical Contractor shall schedule his work as described in the relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1.24 ALTERNATE BIDS

Alternate bid items are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

PART 2 - PRODUCTS Not used.

PART 3 - EXECUTION Not used.

END OF SECTION 260500

## SECTION 260519 - BUILDING WIRE AND CABLE

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Building wire and cable.
- B. Wiring connectors and connections.

## 1.2 RELATED SECTIONS

- A. Section 260533 - Conduit.
- B. Section 260534 - Boxes.
- C. Section 260553 - Identification.

## 1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NECA Standard of Installation (National Electrical Contractors Association).

## 1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, ratings, colors, and configurations.
- B. Test Reports: Indicate procedures and values obtained.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## 1.7 PROJECT CONDITIONS

- A. All wire and cable shall be installed in conduit. This includes all power wiring; fire alarm, sound and communications wire and cable (unless noted otherwise); HVAC control cable; etc.
- B. Verify that field measurements are as shown on Drawings.
- C. Conductor sizes are based on 75° C. copper.
- D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- E. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

## 1.8 COORDINATION

- A. Coordinate Work as agreed upon by design build contract.

## PART 2 - PRODUCTS

## 2.1 BUILDING WIRE AND CABLE

- A. Description: Single conductor insulated building wire.
- B. Conductor: Copper. Solid and stranded as specified below. Minimum #12 AWG, maximum 500 KCMil.
- C. Insulation/Voltage Rating: 600 volts.
- D. Insulation: Dual-rated THHN/THWN or XHHW.
- E. Color Coding:
 

	<u>120/240 volts</u> <u>and 208/120 volts</u>	<u>480/277 volts</u>
Phase A -	Black	Brown
Phase B -	Red	Orange
Phase C -	Blue	Yellow
Neutral -	White	Gray
Ground -	Green	Green
- F. VFC Cable:
  - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
  - 2. Type TC-ER with oversized crosslinked polyethylene insulation, **spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire**, and sunlight- and oil-resistant outer PVC jacket.

## 2.2 WIRING CONNECTORS AND CONNECTIONS

- A. Conductors shall be installed continuous from outlet to outlet with no splicing except within outlet or junction boxes, troughs and gutters. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- B. Use mechanical connectors for copper conductor splices and taps, 8 AWG and larger, except main grounding conductors, which shall be terminated with compression lugs. Tape un-insulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor or use UL-approved insulating covers.
- C. Use insulated spring wire connectors with plastic caps for copper conductors, 10 AWG and smaller, splices and taps in junction boxes, outlet boxes and lighting fixtures, Ideal “wirednuts” or 3M Company “Scotchlock”. “Push wire” type connectors are not acceptable.
- D. “Sta-Kon” or other permanent type crimp connectors shall not be used for branch circuit connections.
- E. Joints in stranded conductors shall be spliced by approved mechanical connectors and gum rubber tape or friction tape. Solderless mechanical connectors for splices and taps, provided with U.L approved insulating covers, may be used instead of mechanical connectors plus tape.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire has been completed.
- C. Verify that raceway installation is complete and supported.

### 3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

### 3.3 WIRING METHODS

- A. Concealed Dry Interior Locations: Use only building wire in raceway.
- B. Exposed Dry Interior Locations: Use only building wire in raceway.
- C. Above Accessible Ceilings: Use only building wire in raceway.
- D. Wet or Damp Interior Locations: Use only building wire in raceway.

- E. Exterior Locations: Use only building wire in raceway.
- F. Underground Installations: Use only building wire in raceway.
- G. VFC Output Circuits: Type TC-ER cable with braided shield in raceway.

### 3.4 INSTALLATION

- A. Install products in accordance with manufacturers instructions.
- B. Route wire and cable as required to meet Project Conditions.
- C. Install cable in accordance with the NECA "Standard of Installation".
- D. Use solid conductor for feeders and branch circuits 10 AWG and smaller, and Class B stranded for larger conductors.
- E. Use conductor not smaller than 12 AWG for power and lighting circuits.
- F. Use conductor not smaller than 14 AWG for fire alarm and control circuits.
- G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (23 m) or branch circuit homeruns longer than 50 feet.
- H. Pull all conductors into raceway at same time.
- I. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- J. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- K. Clean conductor surfaces before installing lugs and connectors.
- L. Identify wire and cable under provisions of Section 260553.
- M. Identify each conductor with its circuit number or other designation indicated on Drawings.
- N. Common neutral multiwire receptacle branch circuits are not permitted. Provide separate, individual neutral conductors for receptacle circuits.

### 3.5 FIELD QUALITY CONTROL

- A. Inspect wire for physical damage and proper connection.
- B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- C. Verify continuity of each branch circuit conductor.



- D. Prior to energizing, feeders, sub-feeders and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be retained onsite as part of the project record documents for review at time of final project inspection.

END OF SECTION 260519

## SECTION 260526 - GROUNDING AND BONDING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Grounding well components.

## 1.2 REFERENCES

- A. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- B. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
- C. NFPA 70 - National Electrical Code.

## 1.3 SUBMITTALS FOR REVIEW

- A. Product Data: Provide for grounding electrodes and connections.

## 1.4 SUBMITTALS FOR INFORMATION

- A. Test Reports: Indicates overall resistance to ground and resistance of each electrode.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

## 1.5 SUBMITTALS FOR CLOSEOUT

- A. Project Record Documents: Record actual locations of components and grounding electrodes.
- B. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

## 1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## PART 2 -PRODUCTS

### 2.1 MECHANICAL CONNECTORS

Material: Cast bronze, brass, or plain malleable iron. Ground clamps shall not be fabricated from aluminum or any aluminum alloy.

### 2.2 WIRE

Material: Stranded copper sized per NEC requirements.

### 2.3 GROUNDING WELL COMPONENTS

- A. Well Pipe: 8 inch NPS (DN200) by 24 inch (600 mm) long PVC pipe with belled end.
- B. Well cover: Cast iron with legend "GROUND" embossed on cover.

## PART 3 -EXECUTION

### 3.1 EXAMINATION

Coordination and Meetings: Verify existing conditions prior to beginning.

### 3.2 INSTALLATION

- A. Quality Control: Manufacturer's instructions shall be followed.
- B. Provide bonding to meet Regulatory Requirements.
- C. Provide separate, insulated conductor within each feeder and branch circuit raceway.
- D. Equipment Grounding Conductor: The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per the NEC (Table 250-122) shall be run in all raceways. Terminate each end on suitable lug, bus, or bushing. Exceptions are as follows:
  - 1. Raceways for telecommunications.
  - 2. Raceways for data.
  - 3. Raceways for audio conductors.
  - 4. Services.

- E. Equipment grounding continuity shall be maintained through flexible conduit as required in previous sections.
- F. Grounding conductors shall be installed as to permit the shortest and most direct path from equipment to ground. All connections to ground conductors shall be accessible for inspection and made with approved solderless connectors, brazed or bolted to the equipment or structure to be grounded. All contact surfaces shall be thoroughly cleaned before connections are made to insure good metal to metal contact.
- G. All equipment housings and/or enclosures, and all non-current carrying metallic parts of electrical equipment, raceway systems, etc., shall be effectively and adequately bonded to ground.
- H. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per the NEC and lugged to the box.
- I. An equipment ground bus shall be installed in each panelboard for terminating equipment grounding conductors.
- J. All wiring devices equipped with grounding connections shall be permanently and securely connected to the enclosure in which they are mounted with a copper grounding jumper.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4, or provide for qualified technicians to perform testing according to the manufacturer's recommendations.

END OF SECTION 260526

## SECTION 260529 - SUPPORTING DEVICES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

## 1.2 REFERENCES

- A. NECA - National Electrical Contractors Association.
- B. ANSI/NFPA 70 - National Electrical Code.

## 1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data for fastening systems.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

## 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## PART 2 - PRODUCTS

## 2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance. See Specifications Section 260500, Para. 1.14 for additional hardware corrosion resistance requirements.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Anchors and Fasteners:
  - 1. Concrete Structural Elements: Use expansion anchors.
  - 2. Steel Structural Elements: Use beam clamps.

3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
5. Solid Masonry Walls: Use expansion anchors.
6. Sheet Metal: Use sheet metal screws or bolts
7. Wood Elements: Use wood screws.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not use powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
- I. Conduits installed on the interior of exterior building walls shall be spaced away from the wall surface a minimum of 1/4 inch (65mm) using "clamp-backs" or struts.
- J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION 260529

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Metal conduit.
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Electrical metallic tubing.
- E. Nonmetallic conduit.
- F. Surface Raceway

## 1.2 RELATED SECTIONS

- A. Section 260534 - Boxes.
- B. Section 260526 - Grounding and Bonding.
- C. Section 260529 - Supporting Devices.
- D. Section 260553 - Electrical Identification.

## 1.3 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
- C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- D. ANSI/NFPA 70 - National Electrical Code.
- E. NECA "Standard of Installation".
- F. NEMA TC2 - Schedule 40 PVC
- G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

## 1.4 DESIGN REQUIREMENTS

Conduit Size: ANSI/NFPA 70.

### 1.5 SUBMITTALS

- A. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, fittings and conduit bodies.

### 1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual routing of conduits larger than 2 inches (51 mm).

### 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept conduit on site. Inspect for damage.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

### 1.9 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

## PART 2 - PRODUCTS

### 2.1 CONDUIT REQUIREMENTS

- A. Size: Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size being ½ inch, except homeruns minimum size shall be ¾". Flexible metal and watertight ("sealtite") conduit in size ½ inch and larger are acceptable for motor, appliance and fixture connections provided green ground wire is installed (see Section 260526) and NEC is followed.
- B. All conduit will be provided with insulated throat.



- C. Underground Installations:
  - 1. More than Five Feet from Foundation Wall: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
  - 2. Within Five Feet from Foundation Wall: Use rigid steel conduit.
  - 3. In or Under Slab on Grade: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
  - 4. Minimum Size: 1 inch (25 mm).
- D. Outdoor Locations, Above Grade: Use rigid steel conduit.
- E. In Slab Above Grade:
  - 1. Use rigid steel conduit.
  - 2. Maximum Size Conduit in Slab: 3/4 inch (19 mm).
- F. Wet and Damp Locations: Use rigid steel conduit.
- G. Dry Locations:
  - 1. Concealed: Use rigid steel conduit, intermediate metal conduit or electrical metallic tubing. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT shall not be installed:
    - a. where tubing, couplings, elbows and fittings would be in direct contact with the earth.
    - b. underground (in/below slab-on-grade or in earth).
    - c. any location outdoors where the tubing, etc., would be subjected to the elements.
    - d. where subject to severe corrosive influence.
    - e. where subject to severe physical damage.
  - 2. Exposed: Use rigid steel conduit or intermediate metal conduit.

## 2.2 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Plastic-Coated Rigid Steel Conduit: ANSI C80.1, 40 mil PVC coating.
- C. Intermediate Metal Conduit (IMC): Rigid steel.
- D. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit with all steel fittings.

## 2.3 FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction.
- B. Fittings: ANSI/NEMA FB 1, steel.

## 2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction with PVC jacket.
- B. Fittings: ANSI/NEMA FB 1, steel or nonmetallic type.

## 2.5 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type, insulated throat.

## 2.6 NONMETALLIC CONDUIT

- A. Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

## 2.7 ONE PIECE SURFACE METAL RACEWAY

- A. The raceway shall be dual channel (one side for power and one side for data) with a base and cover factory assembled.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. A hand operated cutting tool shall be available for the base and cover to ensure clean, square cuts.
- D. A full complement of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.
- E. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single- and multiple-gang configurations up to six-gang. They shall range in depth from 0.94" to 2.75" [23.88mm to 69.85mm]. Single-gang boxes shall allow for snap-on and fastener application. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. All device and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.
- F. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.
- G. Raceway shall be paintable to match adjacent colors.
- H. Raceway shall be painted by Electrical Contractor.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Circuiting is shown schematically. Exact routing of branch circuits may be varied to suit building construction; however, the combination of circuits within raceways and panelboard connections shall not be changed from those shown on the drawings.
- B. Raceways shall be installed concealed in finished areas. Where construction does not permit concealed raceways and where indicated on the drawings, raceways shall be run exposed. Exposed raceways shall be run parallel to, or at a right angle with the building walls. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- C. Where any run of rigid conduit may change to a run of EMT or vice-versa, each change shall be made in a junction or outlet box with each conduit terminated separately therein. Rigid conduit to EMT (or vice-versa) adapters shall not be permitted.
- D. Install conduit in accordance with NECA "Standard of Installation".
- E. Arrange conduit to maintain headroom and present neat appearance.
- F. Maintain adequate clearance between conduit and piping.
- G. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
- H. Cut conduit square using saw or pipecutter and de-burr cut ends.
- I. Bring conduit to shoulder of fittings; fasten securely.
- J. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- K. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows, or hydraulic one-shot bender, to fabricate bends in metal conduit larger than 2 inch size.
- L. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- M. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.
- N. Provide suitable pull string in each empty conduit except sleeves and nipples.
- O. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- P. The raceway system shall not be relied on for grounding continuity. Ground and bond conduit under provisions of Section 260526.
- Q. Identify conduit under provisions of Section 260553.

- R. The use of “LB’s” shall be limited where possible. Where necessary to use “LB’s” sized above 2 inch, mogul units shall be installed.
- S. Where concentric, eccentric or over-sized knockouts are encountered, a grounding type insulated bushing shall be provided.
- T. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
- U. Arrange supports to prevent misalignment during wiring installation.
- V. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- W. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- X. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- Y. Do not attach conduit to ceiling support wires.
- Z. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in lighting and appliance branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the National Electrical Code.
- AA. The term “fittings” includes couplings, connectors, offsets, LBs, etc.
- BB. No pressure cast (pot metal) fittings or conduit bodies shall be allowed.
- CC. Outlets, junction, taps, etc., on exposed rigid metal conduit shall be cast metal conduit fittings or cast metal boxes of the type and size appropriate for the location. Sheet steel outlet boxes shall not be permitted on exposed raceway runs except at or near a ceiling for interior construction.
- DD. EMT couplings and terminations shall be made utilizing steel-plated hexagonal compression connectors. No set screw or indented type fittings shall be utilized.
- EE. EMT couplings and terminations shall be “concrete tight” where buried in masonry or concrete. EMT fittings, where installed in damp locations, shall be of the “raintight” type.
- FF. Install nonmetallic conduit in accordance with manufacturer’s instructions.
- GG. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- HH. PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls.

- II. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.
- JJ. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.
- KK. The placement of conduit in floor slabs shall be thoroughly coordinated with the General Contractor to avoid conflicts with steel reinforcing bars, reductions in net concrete sections and floor penetrations.
- LL. Route conduit under slab from point-to-point.
- MM. Where underground or underslab raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of plastic -coated rigid steel.
- NN. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.
- OO. Service entrance raceways run inside building foundation walls shall be buried at least eighteen (18) inches below grade or encased with a minimum of two (2) inches of concrete on all sides. Concrete encasement shall extend to the service equipment for raceways exposed above grade in crawl spaces.
- PP. Encased raceways shall be of a type approved by the NEC as “suitable for concrete encasement”.
- QQ. Encased raceways shall have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600 volts, which shall have a minimum cover of thirty (30) inches.
- RR. Branch circuit raceways run underground external to building foundation walls shall be run in raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as “suitable for direct burial.” Minimum raceway size shall be 1 inch.
- SS. Raceways run underground, internal to building foundation walls shall be of a type, and installed by a method approved by the NEC.
- TT. Raceways that penetrate outside walls, ceilings from conditioned space or other similar condition shall be effectively sealed to prevent condensation from infiltrating humid air.
- UU. Where raceways pass through a below grade wall, from a conditioned interior building space, the raceway shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type “FSK” thru-wall fitting with “FSKA” membrane clamp adapter if required.
- VV. All underground raceways shall be identified by underground line marking tape within the provisions of Section 260553. The tape to be located directly above the raceway and 6 to 8 inches below finished grade.
- WW. EMT conduit provided below roof deck shall be installed 1 1/2 inches away from the deck to allow for screws not to penetrate the EMT conduit during reroofing.

- XX. Conduits, JB's, Troughs, any enclosure when mounted outside on the walls, shall be off the walls by one inch.
- YY. Surface metal raceways shall be used only where indicated on the drawings. All hardware and supports shall be per NEC and supplied by with raceway.
- ZZ. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

END OF SECTION 260533

## SECTION 260534 - BOXES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.

## 1.2 RELATED SECTIONS

- A. Section 262726 - Wiring Devices: Wall plates in finished areas.
- B. Section 260529 – Supporting Devices.

## 1.3 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA 70 - National Electrical Code.

## 1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide manufacturer's catalog information showing dimensions and configurations.

## 1.5 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## PART 2 - PRODUCTS

### 2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes (for interior conditioned spaces only): NEMA OS 1, galvanized steel.
  - 1. Junction, switch, receptacle and outlet boxes for interior use in dry locations shall be zinc coated or cadmium plated sheet steel, 4" square and 2-1/8" deep, unless otherwise indicated on the contract drawings. Smaller and shallower outlet boxes will be permitted only by special permission of the Architect/Engineer where such boxes are necessary due to structural conditions encountered. Where larger junction boxes are required, they shall be fabricated from No. 10, 12, 14 or 16 gauge sheet steel as required by the Underwriters Laboratories, Inc., and galvanized after fabrication. All junction boxes shall have screw fastened covers. Outlet boxes shall be provided with extension plaster rings where required by structural and finish conditions. Sheet steel boxes shall be as manufactured by Appleton, Raco, Steel City or Spring City.
  - 2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 2 inch (13 mm) male fixture studs where required.
  - 3. Concrete Ceiling Boxes: Concrete type.
- B. Cast Boxes (for all exterior and exposed unconditioned spaces): NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs. Cast boxes shall be by Crouse-Hinds, Appleton, O. Z. Gedney or Killark.

### 2.2 PULL AND JUNCTION BOXES

Sheet Metal Boxes: NEMA OS 1, galvanized steel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

Verify locations of outlets prior to rough-in.

### 3.2 INSTALLATION

- A. Install boxes in accordance with NECA "Standard of Installation".
- B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Set wall mounted boxes at elevations to accommodate mounting heights indicated and specified in section for outlet device. Boxes are shown on Drawings in approximate locations unless



dimensioned. Adjust box location up to 10 feet (3 m) if required to accommodate intended purpose. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes. Use flush mounting outlet box in finished areas. Use stamped steel bridges to fasten flush mounting outlet box between studs.

### 3.3 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

### 3.4 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 260534

## SECTION 260553 - ELECTRICAL IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.
- D. Wiring device plates marking.
- E. Underground warning tape.

## 1.2 REFERENCES

ANSI/NFPA 70 - National Electrical Code.

## 1.3 SUBMITTALS

- A. Product Data: Provide catalog data for nameplates, labels, and markers.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

## 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## PART 2 - PRODUCTS

## 2.1 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic as follows:

Furnish and install engraved laminated phenolic nameplates for all electrical equipment supplied under this contract for identification of system, equipment controlled or served, phase, voltage, ampacity, etc. Nameplates shall be securely attached to equipment with stainless steel

screws, and shall identify by name the equipment controlled, attached, etc. Embossed, self adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:

1. Blue surface with white core for all 120/208 volt equipment.
2. Black surface with white core for 277/480 volt equipment.
3. Bright red surface with white core for all equipment related to fire alarm system.
4. Dark red (burgundy) surface with white core for all equipment related to Security.
5. Green surface with white core for all equipment related to "emergency" systems.
6. Orange surface with white core for all equipment related to telephone systems.
7. Brown surface with white core for all equipment related to data systems.
8. White surface with black core for all equipment related to paging systems.
9. Purple surface with white core for all equipment related to TV systems.

B. Locations:

1. Each electrical distribution and control equipment enclosure (safety switches, panelboards, transformers, etc.)
2. Communication cabinets.
3. Pull and splice boxes.

C. Letter Size: Letters shall be a minimum of 1/2 inch (13 mm) high.

## 2.2 WIRE MARKERS

A. Description: Split sleeve type wire markers or approved equivalent.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on drawings.
2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams on drawings.

## 2.3 CONDUIT, RACEWAY AND BOX MARKING

Paint visible surfaces of exposed junction and outlet boxes and covers of raceway systems above lay-in and other accessible ceilings. Paint all boxes and covers before installation. Paint exposed conduit and raceways at ten foot minimum intervals with a 6 inch wide band in accordance with the color scheme outlined above. Mark conduits at junction boxes above accessible ceilings with the panelboard and circuit numbers of the circuits contained in the raceway using a permanent black marking pen.

## 2.4 WIRING DEVICE PLATES MARKING

A. Description:

1. Adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed, black lettering on a clear background, to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal.
2. Print circuit number on flag type plastic cable tie with a permanent marker (Sharpie, etc.)

and attach to conductors in outlet box. Flag shall be readily visible upon removal of device plate.

- B. Locations: Each receptacle device plate. Apply centered on the lower portion below the receptacle, parallel to the lower surface.
- C. Legend: Typed labels to indicate panel and circuit number feeding the device (i.e., RPA-24).

## 2.5 UNDERGROUND WARNING TAPE

6 inch (150 mm) wide, 4 mils thick, minimum, permanent plastic tape compounded for direct burial, detectable type, colored bright yellow with suitable continuous warning legend describing buried electrical lines.

## PART 3 - EXECUTION

### 3.1 PREPARATION

Degrease and clean surfaces to receive nameplates and labels.

### 3.2 APPLICATION

- A. Install nameplate parallel to equipment lines.
- B. Secure nameplate to equipment front using self tapping stainless steel screws, lockwashers and acorn nuts as shown on the Drawings.
- C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- D. Install receptacle identification labels at top of each device plate, parallel to upper surface.
- E. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.
- F. Update all existing panelboard directories where changes are made. Provide new panel schedule cards as required to maintain legibility.
- G. Identify underground conduits using one underground warning tape per trench at 6 - 8 inches below finished grade.
- H. Install adhesive backed labels and nameplates only when ambient temperature and humidity conditions for adhesive use are within range recommended by manufacturer.

END OF SECTION 260553

## SECTION 260580 - EQUIPMENT WIRING SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

Electrical supply for, and connections to, equipment specified under other Divisions.

## 1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 23: Heating Ventilating and Air Conditioning.
- B. Specification 260533 – Conduit.
- C. Specification 260519 - Building Wire and Cable.
- D. Specification 260534 – Boxes.
- E. Specification 260526 - Grounding and Bonding.

## 1.3 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices.
- B. NEMA WD 6 - Wiring Device Configurations.
- C. ANSI/NFPA 70 - National Electrical Code.

## 1.4 SUBMITTALS

- A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

## 1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

- C. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26.

#### 1.6 COORDINATION

- A. Coordinate work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- E. Sequence electrical connections to coordinate with start-up schedule for equipment.

### PART 2 - PRODUCTS

#### 2.1 CORDS AND CAPS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
- C. Cord Construction: ANSI/NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify conditions under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
- B. Verify that equipment is ready for electrical connection, wiring, and energization.

#### 3.2 ELECTRICAL WORK IN CONNECTION WITH OTHER CONTRACTS

- A. The Electrical Contractor shall provide a source of power for mechanical equipment shown on the Drawings. Provide pigtails, flexible connections, conductors, raceways, circuit breakers,

safety switches, receptacles, junction boxes, panelboards and/or wiring troughs as detailed in this section and/or as shown on the Drawings.

- B. Safety switches, fuses, variable speed drives, magnetic motor starters, magnetic motor starter overload elements, control devices and sensors and control wiring and control raceways for such equipment will be provided and installed by the contractor providing the equipment. The locations of local disconnecting means furnished by other divisions are shown on the respective division's Drawings. Coordinate exact locations with the contractor providing the equipment. Coordinate and verify all electrical requirements, connections, phasing and rotation, overcurrent and overload protective device sizes with the Contractor providing the equipment or the Owner in the case of Owner-furnished equipment. See other specifications divisions for further explanation of contractor responsibility. Do not apply power to equipment without the permission of the contractor providing the equipment.
- C. Mechanical (Division 23) Equipment.
  - 1. The Electrical Contractor shall furnish and install power wiring up to a defined termination point (see Contract Drawings) consisting of a junction box, trough, or a properly sized starter, variable frequency drive or fused safety disconnect switch for each item of equipment specified in the Mechanical Contract. The termination point shall be located adjacent to the associated equipment, unless equipment has built-in disconnects, in which case the Electrical Contractor shall bring his conductors to a junction box adjacent to the equipment, leaving sufficient marked conductor tails for extension by the Contractor providing the equipment. The Contractor providing the equipment shall make final connections from the junction box to the equipment.
  - 2. HVAC Control Panels, Control Equipment and Computers:
    - a. The Electrical Contractor shall provide and install power wiring to the control panel(s) terminals or to a receptacle, as required. The Electrical Contractor shall provide sufficient electrical circuits from the fire alarm control panel to allow all required mechanical equipment operations during fire mode. See Division 23 Specifications for further definition of the required fire alarm/mechanical control system interface and operation sequence.
    - b. All equipment less than 110 volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, safety switches beyond Electrical Contractor termination point and other appurtenances associated with equipment in Division 23, shall be furnished, installed and wired under Division 23. All wiring required for controls and instrumentation, not indicated on the Drawings, shall be furnished and installed by the Mechanical Contractor.
  - 3. Heat Tape: Electrical Contractor shall provide junction boxes or weatherproof, ground fault interrupting type duplex receptacles for heat tapes. See electrical drawings for locations and confirm exact locations and termination requirements with the Mechanical Contractor.
  - 4. Refer to Division 23 for additional detail concerning electrical connections to Division 23 equipment, specifically Specification 230511.

### 3.3 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.

- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Install disconnect switches, controllers, control stations, and control devices as indicated.
- G. Modify equipment control wiring with terminal block jumpers as indicated.
- H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 260580



## SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Distribution panelboards.
- B. Lighting and appliance branch circuit panelboards.

## 1.2 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.
- C. Section 262813 - Fuses.

## 1.3 REFERENCES

- A. NECA Standard of Installation (published by the National Electrical Contractors Association).
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

## 1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide manufacturer's catalog information showing dimensions, ratings, features, colors, and configurations.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

## 1.5 SUBMITTALS FOR INFORMATION

- A. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

#### 1.6 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- B. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

#### 1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

#### 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

#### 1.9 MAINTENANCE MATERIALS

- A. Furnish two of each panelboard key.

### PART 2 - PRODUCTS

#### 2.1 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:
  - 1. Cutler Hammer.
  - 2. General Electric.
  - 3. Siemens.
  - 4. Square D.
- B. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- C. Service Conditions:
  - 1. Temperature: 104° F. (40° C.).
  - 2. Altitude: N/A.
  - 3. Terminal Rating: 75° C. minimum.
- D. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide 200% copper neutral bus where indicated. Provide insulated ground bus where scheduled.

- E. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208 volt panelboards.
- F. Circuit Breakers: NEMA AB 1, bolt-on type.
  - 1. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
  - 2. Current Limiting Molded Case Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- G. Enclosure: NEMA PB 1, Type 1 or Type 3R.
- H. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 24 inches wide for 480 volt panelboards.
- I. Cabinet Front: Flush and Surface cabinet front door-in-door type (hinged trims are not acceptable) with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- J. Series rated breakers not allowed.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Panelboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.22 for additional requirements.
- D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard. Final typed panelboard directories installed in the panelboard door pocket shall include final actual room names and numbers in addition to the general description shown on the panel schedules on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.

- H. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling and below floor. Minimum spare conduits: 5 empty 1 inch. Identify each as SPARE.
- I. Ground and bond panelboard enclosure according to Section 260526.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4, or provide for qualified technicians to perform testing according to the manufacturer's recommendations.

### 3.3 ADJUSTING

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416

## SECTION 262813 - FUSES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Fuses.

## 1.2 REFERENCES

- A. NFPA 70 - National Electric Code.
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.

## 1.3 SUBMITTALS

- A. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

## 1.4 PROJECT RECORD DOCUMENTS

- A. Record actual fuse sizes.

## 1.5 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## 1.7 EXTRA MATERIALS

- A. Provide no less than 10% of each fuse size and type installed, with a minimum of at least one set of three of each.
- B. Provide one fuse puller.

## PART 2 - PRODUCTS

## 2.1 FUSE REQUIREMENTS

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. UL Listed.

	<u>Circuit Type</u>	<u>Fuse type</u>
1.	Service Entrance and Feeder Circuits over 600Amp 200K Amp interrupting rating.	Class L
2.	Service Entrance and Feeder Circuits 600Amp or less 200K Amp interrupting rating.	Class RK1 or J
3.	Motor, Motor Controller and Transformer Circuits 200K Amp interrupting rating.	RK5

- D. For individual equipment where fault current does not exceed 50KA use Class K5 fuses with 50KA interrupting rating.
- E. Fusible safety switches with short-circuit withstand ratings of 100KA or 200KA require Class R or Class J rejection fuse block feature.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813

## SECTION 262816 - ENCLOSED SWITCHES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Fusible switches.
- B. Nonfusible switches.

## 1.2 RELATED SECTIONS

- A. Section 260529 – Supporting Devices.
- B. Section 260553 – Electrical Identification.
- C. Section 262813 – Fuses.

## 1.3 REFERENCES

- A. NECA - Standard of Installation (published by the National Electrical Contractors Association).
- B. NEMA FU1 - Low Voltage Cartridge Fuses.
- C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).
- E. NFPA 70 - National Electrical Code.

## 1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide switch ratings and enclosure dimensions.

## 1.5 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of enclosed switches in project record documents.

## 1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- 1. Cutler Hammer.
- 2. General Electric.
- 3. Siemens.
- 4. Square D.

### 2.2 RATINGS

- A. Service Conditions:
  - 1. Temperature: 104°F. (40°C.).
  - 2. Altitude: N/A.
  - 3. Terminal Rating: 75°C. minimum.
- B. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical, or as indicated.

### 2.3 FUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.
- B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

### 2.4 NONFUSIBLE SWITCH ASSEMBLIES

Description: NEMA KS 1, Type HD with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.

### 2.5 ENCLOSURES

- A. Fabrication: NEMA KS 1.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.



## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation".
- B. Switches shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.23 for additional requirements.
- C. Install fuses in fusible disconnect switches serving Division 26 equipment.
- D. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

## 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4, or provide for qualified technicians to perform testing according to the manufacturer's recommendations.

END OF SECTION 262816