

DELAWARE STATE UNIVERSITY  
CONTRACT # FD-15-098

SPECIFICATIONS  
FOR

Education & Humanities Boiler Replacement

IN

East Dover Hundred - Kent County  
Dover, Delaware

PREPARED  
BY

DEDC, LLC.

ISSUED FOR BID  
March 23, 2016



**TABLE OF CONTENTS**

A. Specifications for this project are arranged in accordance with the Construction Specification Institute numbering system and format. Section numbering is discontinuous and all numbers not appearing in the Table of Contents are not used for this Project.

B. DOCUMENTS BOUND HEREWITH

**DIVISION 00 – PROCUREMENT AND CONTRACT REQUIREMENTS**

INTRODUCTORY INFORMATION

00 01 01 – PROJECT TITLE PAGE	1 page
00 01 10 – TABLE OF CONTENTS	2 pages
00 01 15 – LIST OF DRAWING SHEETS	1 page

PROCUREMENT REQUIREMENTS

00 11 16 – INVITATION TO BID	1 page
00 21 13 – INSTRUCTIONS TO BIDDERS	12 pages
00 41 13 – BID FORM	4 pages
00 43 13 – BID BOND	1 page
00 43 36 – PROPOSED SUBCONTRACTOR LIST	1 page
00 45 19 – NON-COLLUSION STATEMENT	1 page
00 46 00 – AFFIDAVIT OF EMPLOYEE DRUG TESTING PROGRAM	1 page

CONTRACTING REQUIREMENTS

00 52 13 – STANDARD FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR	1 page
00 54 13 – SUPPLEMENT TO AGREEMENT BETWEEN OWNER & CONTRACTOR A101-2007	1 page
00 61 13.13 – PERFORMANCE BOND	2 pages
00 61 13.16 – PAYMENT BOND	2 pages
00 62 76 – SAMPLE APPLICATION AND CERTIFICATE FOR PAYMENT FORMS	1 page
00 72 13 – GENERAL CONDITIONS TO THE CONTRACT	1 page
00 73 13 – SUPPLEMENTARY GENERAL CONDITIONS	10 pages
00 73 46 – WAGE RATE REQUIREMENTS	1 page
00 81 13 – GENERAL REQUIREMENTS	13 pages
00 81 14 – EMPLOYEE DRUG TESTING REPORT FORMS	2 pages

INTRODUCTORY INFORMATION

00 01 01 - PROJECT TITLE PAGE	1 page
00 01 10 - TABLE OF CONTENTS	2 pages
00 01 15 - LIST OF DRAWING SHEETS	1 page

DIVISION 01 -- GENERAL REQUIREMENTS

01 10 00 – SUMMARY	1page
01 30 00 - ADMINISTRATIVE REQUIREMENTS	4 pages
01 40 00 – QUALITY REQUIREMENTS	3 pages
01 60 00 - PRODUCT REQUIREMENTS	4 pages
01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS	7 pages
01 78 00 - CLOSEOUT SUBMITTALS	3 pages
01 79 00 - DEMONSTRATION AND TRAINING	3 pages
01 91 13 - GENERAL COMMISSIONING REQUIREMENTS	3 pages

DIVISION 03 – CONCRETE

03 30 00 - CAST-IN-PLACE CONCRETE	4 pages
-----------------------------------	---------

DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

07 84 00 – FIRESTOPPING	3 pages
-------------------------	---------

DIVISION 22 – PLUMBING

22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT	2 pages
22 07 19 – PLUMBING PIPING INSULATION	3 pages
22 10 05 – PLUMBING PIPING	7 pages
22 10 06 – PLUMBING PIPE SPECIALTIES	2 pages

DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	2 pages
23 05 19 - METERS AND GAGES FOR HVAC PIPING	2 pages
23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	2 pages
23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC	5 pages
23 07 19 – HVAC PIPING INSULATION	4 pages
23 09 50 - BUILDING AUTOMATION SYSTEM (BAS) GENERAL	12 pages

23 09 51 - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS	12 pages
23 09 53 - BAS FIELD PANELS	9 pages
23 09 54 – BAS COMMUNICATION DEVICES	3 pages
23 09 55 - BAS SOFTWARE AND PROGRAMMING	16 pages
23 09 58 - SEQUENCE OF OPERATION	4 pages
23 09 59 - BAS SYSTEM COMMISSIONING	9 pages
23 09 69 – VARIABLE FREQUENCY CONTROLLERS	4 pages
23 21 13 - HYDRONIC PIPING	6 pages
23 21 14 - HYDRONIC SPECIALTIES	3 pages
23 21 23 – HYDRONIC PUMPS	2 pages
23 51 00 – BREECHING, CHIMNEYS, AND STACKS	2 pages
23 52 16 – CONDENSING BOILERS	5 pages
<u>DIVISION 26 – ELECTRICAL</u>	
26 05 01 - MINOR ELECTRICAL DEMOLITION	2 pages
26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 V AND LESS)	5 pages
26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	3 pages
26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	3 pages
26 05 34 – CONDUIT	5 pages
26 05 37 – BOXES	4 pages
26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS	3 pages
26 27 17 - EQUIPMENT WIRING	2 pages
26 27 26 - WIRING DEVICES	4 pages
26 28 17 - ENCLOSED CIRCUIT BREAKERS	3 pages
26 29 12 – ENCLOSED CONTROLLERS	2 pages
26 51 00 – INTERIOR LIGHTING	3 pages

**END OF SECTION 00 01 10**

**LIST OF DRAWING SHEETS**

COVER SHEET

- M-0 MECHANICAL- NOTES, LEGENDS, ABBREVIATIONS, & SCHEDULES
- MD-1 MECHANICAL- DEMOLITION- BOILER ROOM PLAN & HW PIPING DIAGRAM
- M-1 MECHANICAL- NEW WORK- BOILER ROOM PLAN & HW PIPING DIAGRAM
- M-2 MECHANICAL- CONTROLS
- M-3 MECHANICAL- DETAILS & DIAGRAMS
- E-0 ELECTRICAL- NOTES, LEGENDS & ABBREVIATIONS
- E-1 ELECTRICAL- DEMOLITION & NEW WORK- BOILER ROOM

**END OF SECTION 00 01 15**

## INVITATION TO BID

Sealed bids for Delaware State University Contract No. **FD-15-098 – Education & Humanities Boiler Replacement** will be received by the Delaware State University, in the reception area of the Purchasing Office in the Administration Building, 1200 N. DuPont Highway, Dover, DE 19901-2277 (Third Floor), until **2:00PM EST** local time on **April 14, 2016**, at which time they will be publicly opened and read aloud in the Conference Room. Bidder bears the risk of late delivery. Any bids received after the stated time will be returned unopened.

Project involves removal and disposal of existing conventional boilers. Provide and install high efficiency boilers.

A **MANDATORY** Pre-Bid Meeting will be held on **March 30, 2016**, at **1:30PM EST** at **Education & Humanities Main Lobby** for the purpose of establishing the listing of subcontractors and to answer questions. Representatives of each party to any Joint Venture must attend this meeting. **ATTENDANCE OF THIS MEETING IS A PREREQUISITE FOR BIDDING ON THIS CONTRACT.**

Sealed bids shall be addressed to the Delaware State University c/o the Purchasing Department, Administration Building, Room 321 (Third Floor), Dover, DE 19901-2277, Attn: Jessica Wilson, Director of Purchasing. The outer envelope should clearly indicate: "**DSU CONTRACT NO. FD-15-098 –Education & Humanities Boiler Replacement- SEALED BID - DO NOT OPEN.**"

Contract documents may be obtained or reviewed at the office of DEDC LLC. upon receipt of \$500.00 per set/non-refundable, starting on the day of the mandatory pre-bid. Checks are to be made payable to "DEDC LLC." Alternatively, in consideration of our environment, and in alignment with the University's sustainability initiatives, bidders may request an electronic copy of the bidding documents by submitting a written request to [constructionbid@desu.edu](mailto:constructionbid@desu.edu). Delaware State University will track all bidders and ensure plan holder receive all addenda.

### Summary of Events and Dates:

<b>March 30, 2016</b>	<b>Mandatory Site Visit at Education &amp; Humanities Main Lobby (1:30PM EST)</b>
<b>April 11, 2016</b>	<b>Deadline for Questions (4:00PM EST)</b>
<b>April 12, 2016</b>	<b>Posting of Answers to Contractor Questions (4:00PM EST)</b>
<b>April 12, 2016</b>	<b>Final Date for Addendums</b>
<b>April 14, 2016</b>	<b>Proposals Due (2:00 PM EST)</b>
<b>April 21, 2016</b>	<b>Contractor Selection Date</b>
<b>May 2, 2016</b>	<b>Anticipated Start of Construction Date (subject to change)</b>
<b>May 16, 2016</b>	<b>Latest Date for Contract Award</b>
<b>September 1, 2016</b>	<b>Substantial Completion</b>

Bidders will not be subject to discrimination on the basis of race, creed, color, sex, sexual orientation, gender identity or national origin in consideration of this award, and Minority Business Enterprises, Disadvantaged Business Enterprises, Women-Owned Business Enterprises and Veteran-Owned Business Enterprises will be afforded full opportunity to submit bids on this contract. Each bid must be accompanied by a bid security equivalent to ten percent of the bid amount and all additive alternates. The successful bidder must post a performance bond and payment bond in a sum equal to 100 percent of the contract price upon execution of the contract. Delaware State University reserves the right to

reject any or all bids and to waive any informalities therein. Delaware State University may extend the time and place for the opening of the bids from that described in the advertisement, with not less than two calendar days' notice by certified delivery, facsimile machine or other electronic means to those bidders receiving plans.

### **DRUG TESTING REQUIREMENTS FOR LARGE PUBLIC WORKS**

Pursuant to 29 Del.C. §6908(a)(6), effective as of January 1, 2016, OMB has established regulations that require Contractors and Subcontractors to implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds. The regulations establish the mechanism, standards and requirements of a Mandatory Drug Testing Program that will be incorporated by reference into all Large Public Works Contracts awarded pursuant to 29 Del.C. §6962. Final publication of the identified regulations can be found at the following: [4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects](#)

**END OF ADVERTISEMENT FOR BIDS**

## INVITATION TO BID

Sealed bids for Delaware State University Contract No. **FD-15-098 – Education & Humanities Boiler Replacement** will be received by the Delaware State University, in the reception area of the Purchasing Office in the Administration Building, 1200 N. DuPont Highway, Dover, DE 19901-2277 (Third Floor), until **2:00PM EST** local time on **April 14, 2016**, at which time they will be publicly opened and read aloud in the Conference Room. Bidder bears the risk of late delivery. Any bids received after the stated time will be returned unopened.

Project involves removal and disposal of existing conventional boilers. Provide and install high efficiency boilers.

A **MANDATORY** Pre-Bid Meeting will be held on **March 30, 2016**, at **1:30PM EST** at **Education & Humanities Main Lobby** for the purpose of establishing the listing of subcontractors and to answer questions. Representatives of each party to any Joint Venture must attend this meeting. **ATTENDANCE OF THIS MEETING IS A PREREQUISITE FOR BIDDING ON THIS CONTRACT.**

Sealed bids shall be addressed to the Delaware State University c/o the Purchasing Department, Administration Building, Room 321 (Third Floor), Dover, DE 19901-2277, Attn: Jessica Wilson, Director of Purchasing. The outer envelope should clearly indicate: "**DSU CONTRACT NO. FD-15-098 –Education & Humanities Boiler Replacement- SEALED BID - DO NOT OPEN.**"

Contract documents may be obtained or reviewed at the office of DEDC LLC. upon receipt of \$500.00 per set/non-refundable, starting on the day of the mandatory pre-bid. Checks are to be made payable to "DEDC LLC." Alternatively, in consideration of our environment, and in alignment with the University's sustainability initiatives, bidders may request an electronic copy of the bidding documents by submitting a written request to [constructionbid@desu.edu](mailto:constructionbid@desu.edu). Delaware State University will track all bidders and ensure plan holder receive all addenda.

### Summary of Events and Dates:

<b>March 30, 2016</b>	<b>Mandatory Site Visit at Education &amp; Humanities Main Lobby (1:30PM EST)</b>
<b>April 11, 2016</b>	<b>Deadline for Questions (4:00PM EST)</b>
<b>April 12, 2016</b>	<b>Posting of Answers to Contractor Questions (4:00PM EST)</b>
<b>April 12, 2016</b>	<b>Final Date for Addendums</b>
<b>April 14, 2016</b>	<b>Proposals Due (2:00 PM EST)</b>
<b>April 21, 2016</b>	<b>Contractor Selection Date</b>
<b>May 2, 2016</b>	<b>Anticipated Start of Construction Date (subject to change)</b>
<b>May 16, 2016</b>	<b>Latest Date for Contract Award</b>
<b>September 1, 2016</b>	<b>Substantial Completion</b>

Bidders will not be subject to discrimination on the basis of race, creed, color, sex, sexual orientation, gender identity or national origin in consideration of this award, and Minority Business Enterprises, Disadvantaged Business Enterprises, Women-Owned Business Enterprises and Veteran-Owned Business Enterprises will be afforded full opportunity to submit bids on this contract. Each bid must be accompanied by a bid security equivalent to ten percent of the bid amount and all additive alternates. The successful bidder must post a performance bond and payment bond in a sum equal to 100 percent of the contract price upon execution of the contract. Delaware State University reserves the right to

reject any or all bids and to waive any informalities therein. Delaware State University may extend the time and place for the opening of the bids from that described in the advertisement, with not less than two calendar days' notice by certified delivery, facsimile machine or other electronic means to those bidders receiving plans.

### **DRUG TESTING REQUIREMENTS FOR LARGE PUBLIC WORKS**

Pursuant to 29 Del.C. §6908(a)(6), effective as of January 1, 2016, OMB has established regulations that require Contractors and Subcontractors to implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds. The regulations establish the mechanism, standards and requirements of a Mandatory Drug Testing Program that will be incorporated by reference into all Large Public Works Contracts awarded pursuant to 29 Del.C. §6962. Final publication of the identified regulations can be found at the following: [4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects](#)

**END OF ADVERTISEMENT FOR BIDS**

## **INSTRUCTIONS TO BIDDERS**

### **TABLE OF ARTICLES**

1. DEFINITIONS
2. BIDDER'S REPRESENTATION
3. BIDDING DOCUMENTS
4. BIDDING PROCEDURES
5. CONSIDERATION OF BIDS
6. POST-BID INFORMATION
7. PERFORMANCE BOND AND PAYMENT BOND
8. FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR
9. LIQUIDATED DAMAGES

**ARTICLE 1: GENERAL**

1.1 DEFINITIONS

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

1.2 STATE: The State of Delaware.

1.3 BOARD: The Delaware State University Board of Trustees

1.4 UNIVERSITY: The Delaware State University

1.5 AGENCY: The Delaware State University

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

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

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

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

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

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

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

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

1.14 SUB-BIDDER: A person or entity who submits a Bid to a Bidder for materials or labor, or both for a portion of the Work.

1.15 BID: A complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

- 1.16 BASE BID: The sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents as the base, to which Work may be added or from which Work may be deleted for sums stated in Alternate Bids (if any are required to be stated in the bid).
- 1.17 ALTERNATE BID (or ALTERNATE): An amount stated in the Bid, where applicable, to be added to or deducted from the amount of the Base Bid if the corresponding change in the Work, as described in the Bidding Documents is accepted.
- 1.18 UNIT PRICE: An amount stated in the Bid, where applicable, as a price per unit of measurement for materials, equipment or services or a portion of the Work as described in the Bidding Documents.
- 1.19 SURETY: The corporate body which is bound with and for the Contract, or which is liable, and which engages to be responsible for the Contractor's payments of all debts pertaining to and for his acceptable performance of the Work for which he has contracted.
- 1.20 BIDDER'S DEPOSIT: The security designated in the Bid to be furnished by the Bidder as a guaranty of good faith to enter into a contract with the Agency if the Work to be performed or the material or equipment to be furnished is awarded to him.
- 1.21 CONTRACT: The written agreement covering the furnishing and delivery of material or work to be performed.
- 1.22 CONTRACTOR: Any individual, firm or corporation with whom a contract is made by the Agency.
- 1.23 SUBCONTRACTOR: An individual, partnership or corporation which has a direct contract with a contractor to furnish labor and materials at the job site, or to perform construction labor and furnish material in connection with such labor at the job site.
- 1.24 CONTRACT BOND: The approved form of security furnished by the contractor and his surety as a guaranty of good faith on the part of the contractor to execute the work in accordance with the terms of the contract.
- 1.25 LIQUIDATED DAMAGES: An amount due and payable to the University by the Contractor for additional costs incurred by the University resulting from the Contractor's failure to complete within the Contract time.

## **ARTICLE 2: BIDDER'S REPRESENTATIONS**

- 2.1 PRE-BID MEETING
- 2.1.1 A pre-bid meeting for this project will be held at the time and place designated. Attendance at this meeting is a pre-requisite for submitting a Bid, unless this requirement is specifically waived elsewhere in the Bid Documents.
- 2.2 By submitting a Bid, the Bidder represents that:
- 2.2.1 The Bidder has read and understands the Bidding Documents and that the Bid is made in accordance therewith.
- 2.2.2 The Bidder has visited the site, become familiar with existing conditions under which the Work is to be performed, and has correlated the Bidder's his personal observations with the requirements of the proposed Contract Documents.
- 2.2.3 The Bid is based upon the materials, equipment, and systems required by the Bidding Documents without exception.
- 2.3 JOINT VENTURE REQUIREMENTS

- 2.3.1 For Public Works Contracts, each Joint Venturer shall be qualified and capable to complete the Work with their own forces.
- 2.3.2 Included with the Bid submission, and as a requirement to bid, a copy of the executed Joint Venture Agreement shall be submitted and signed by all Joint Venturers involved.
- 2.3.3 All required Bid Bonds, Performance Bonds, Material and Labor Payment Bonds must be executed by both Joint Venturers and be placed in both of their names.
- 2.3.4 All required insurance certificates shall name both Joint Venturers.
- 2.3.5 Both Joint Venturers shall sign the Bid Form and shall submit a copy of a valid Delaware Business License with their Bid.
- 2.3.6 Both Joint Venturers shall include their Federal E.I. Number with the Bid.
- 2.3.7 In the event of a mandatory Pre-bid Meeting, each Joint Venturer shall have a representative in attendance.
- 2.3.8 Due to exceptional circumstances and for good cause shown, one or more of these provisions may be waived at the discretion of the State.

#### 2.4 ASSIGNMENT OF ANTITRUST CLAIMS

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

### ARTICLE 3: BIDDING DOCUMENTS

#### 3.1 COPIES OF BID DOCUMENTS

- 3.1.1 Bidders may obtain complete sets of the Bidding Documents from the Architectural/Engineering firm designated in the Advertisement or Invitation to Bid in the number and for the deposit sum, if any, stated therein.
- 3.1.2 Bidders shall use complete sets of Bidding Documents for preparation of Bids. The issuing Agency nor the Architect assumes no responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 3.1.3 Any errors, inconsistencies or omissions discovered shall be reported to the Architect immediately.
- 3.1.4 The Agency and Architect may make copies of the Bidding Documents available on the above terms for the purpose of obtaining Bids on the Work. No license or grant of use is conferred by issuance of copies of the Bidding Documents.

#### 3.2 INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS

- 3.2.1 The Bidder shall carefully study and compare the Bidding Documents with each other, and with other work being bid concurrently or presently under construction to the extent that it relates to the Work for which the Bid is submitted, shall examine the site and local conditions, and shall report any errors, inconsistencies, or ambiguities discovered to the Architect.
- 3.2.2 Bidders or Sub-bidders requiring clarification or interpretation of the Bidding Documents shall make a written request to the Architect at least seven days prior to the date for receipt of Bids. Interpretations,

corrections and changes to the Bidding Documents will be made by written Addendum. Interpretations, corrections, or changes to the Bidding Documents made in any other manner shall not be binding.

3.2.3 The apparent silence of the specifications as to any detail, or the apparent omission from it of detailed description concerning any point, shall be regarded as meaning that only the best commercial practice is to prevail and only material and workmanship of the first quality are to be used. Proof of specification compliance will be the responsibility of the Bidder.

3.2.4 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for all permits, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of the Work.

3.2.5 The Owner will bear the costs for all impact and user fees associated with the project.

### 3.3 SUBSTITUTIONS

3.3.1 The materials, products and equipment described in the Bidding Documents establish a standard of quality, required function, dimension, and appearance to be met by any proposed substitution. The specification of a particular manufacturer or model number is not intended to be proprietary in any way. Substitutions of products for those named will be considered, providing that the Vendor certifies that the function, quality, and performance characteristics of the material offered is equal or superior to that specified. It shall be the Bidder's responsibility to assure that the proposed substitution will not affect the intent of the design, and to make any installation modifications required to accommodate the substitution.

3.3.2 Requests for substitutions shall be made in writing to the Architect at least ten days prior to the date of the Bid Opening. Such requests shall include a complete description of the proposed substitution, drawings, performance and test data, explanation of required installation modifications due the substitution, and any other information necessary for an evaluation. The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval shall be final. The Architect is to notify Owner prior to any approvals.

3.3.3 If the Architect approves a substitution prior to the receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding.

3.3.4 The Architect shall have no obligation to consider any substitutions after the Contract award.

### 3.4 ADDENDA

3.4.1 Addenda will be mailed or delivered to all who are known by the Architect to have received a complete set of the Bidding Documents.

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

3.4.3 No Addenda will be issued later than 4 days prior to the date for receipt of Bids except an Addendum withdrawing the request for Bids or one which extends the time or changes the location for the opening of bids.

3.4.4 Each bidder shall ascertain prior to submitting his Bid that they have received all Addenda issued, and shall acknowledge their receipt in their Bid in the appropriate space. Not acknowledging an issued Addenda could be grounds for determining a bid to be non-responsive.

## ARTICLE 4: BIDDING PROCEDURES

### 4.1 PREPARATION OF BIDS

- 4.1.1 Submit the bids on the Bid Forms included with the Bidding Documents.
- 4.1.2 Submit the original Bid Form for each bid. Bid Forms may be removed from the project manual for this purpose.
- 4.1.3 Execute all blanks on the Bid Form in a non-erasable medium (typewriter or manually in ink).
- 4.1.4 Where so indicated by the makeup on the Bid Form, express sums in both words and figures, in case of discrepancy between the two, the written amount shall govern.
- 4.1.5 Interlineations, alterations or erasures must be initialed by the signer of the Bid.
- 4.1.6 BID ALL REQUESTED ALTERNATES AND UNIT PRICES, IF ANY. If there is no change in the Base Bid for an Alternate, enter "No Change". The Contractor is responsible for verifying that they have received all addenda issued during the bidding period. Work required by Addenda shall automatically become part of the Contract.
- 4.1.7 Make no additional stipulations on the Bid Form and do not qualify the Bid in any other manner.
- 4.1.8 Each copy of the Bid shall include the legal name of the Bidder and a statement whether the Bidder is a sole proprietor, a partnership, a corporation, or any legal entity, and each copy shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further give the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current Power of Attorney attached, certifying agent's authority to bind the Bidder.
- 4.1.9 Bidder shall complete the Non-Collusion Statement form included with the Bid Forms and include it with their Bid.
- 4.1.10 In the construction of all Public Works projects for the State of Delaware or any agency thereof, preference in employment of laborers, workers or mechanics shall be given to bona fide legal citizens of the State who have established citizenship by residence of at least 90 days in the State.
- 4.1.11 Each bidder shall include in their bid a copy of a valid Delaware Business License.'
- 4.1.12 Each bidder shall include signed Affidavit(s) for the Bidder and each listed Subcontractor certifying compliance with OMB Regulation 4104- "Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on "Large Public Works Projects." "Large Public Works" is based upon the current threshold required for bidding Public Works as set by the Purchasing and Contracting Advisory Council.
- 4.2 BID SECURITY
  - 4.2.1 All bids shall be accompanied by a deposit of either a good and sufficient bond to the agency for the benefit of the agency, with corporate surety authorized to do business in this State, the form of the bond and the surety to be approved by the agency, or a security of the bidder assigned to the agency, for a sum equal to at least 10% of the bid plus all add alternates, or in lieu of the bid bond a security deposit in the form of a certified check, bank treasurer's check, cashier's check, money order, or other prior approved secured deposit assigned to the State. The bid bond need not be for a specific sum, but may be stated to be for a sum equal to 10% of the bid plus all add alternates to which it relates and not to exceed a certain stated sum, if said sum is equal to at least 10% of the bid. The Bid Bond form used shall be the standard OMB form (attached).
  - 4.2.2 The Agency has the right to retain the bid security of Bidders to whom an award is being considered until either a formal contract has been executed and bonds have been furnished or the specified time has elapsed so the Bids may be withdrawn or all Bids have been rejected.

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

#### 4.3 SUBCONTRACTOR LIST

4.3.1 As required by Delaware Code, Title 29, section 6962(d)(10)b, each Bidder shall submit with their Bid a completed List of Sub-Contractors included with the Bid Form. NAME ONLY ONE SUBCONTRACTOR FOR EACH TRADE. A Bid will be considered non-responsive unless the completed list is included.

4.3.2 Provide the Name and Address for each listed subcontractor. Addresses by City, Town or Locality, plus State, will be acceptable.

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

#### 4.4 EQUALITY OF EMPLOYMENT OPPORTUNITY ON PUBLIC WORKS

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

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

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

#### 4.5 PREVAILING WAGE REQUIREMENT

4.5.1 Wage Provisions: In accordance with Delaware Code, Title 29, Section 6960, renovation projects whose total cost shall exceed \$15,000, and \$100,000 for new construction, the minimum wage rates for various classes of laborers and mechanics shall be as determined by the Department of Labor, Division of Industrial Affairs of the State of Delaware.

4.5.2 The prevailing wage shall be the wage paid to a majority of employees performing similar work as reported in the Department's annual prevailing wage survey or in the absence of a majority, the average paid to all employees reported.

4.5.3 The employer shall pay all mechanics and labors employed directly upon the site of work, unconditionally and not less often than once a week and without subsequent deduction or rebate on any account, the full amounts accrued at time of payment, computed at wage rates not less than those stated in the specifications, regardless of any contractual relationship which may be alleged to exist between the employer and such laborers and mechanics.

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

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

4.6 SUBMISSION OF BIDS

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

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

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

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

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

4.7 MODIFICATION OR WITHDRAW OF BIDS

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

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

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

**ARTICLE 5: CONSIDERATION OF BIDS**

5.1 OPENING/REJECTION OF BIDS

5.1.1 Unless otherwise stated, Bids received on time will be publicly opened and will be read aloud. An abstract of the Bids will be made available to Bidders.

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

5.1.3 If the Bids are rejected, it will be done within thirty (30) calendar day of the Bid opening.

5.2 COMPARISON OF BIDS

5.2.1 After the Bids have been opened and read, the bid prices will be compared and the result of such comparisons will be made available to the public. Comparisons of the Bids may be based on the Base

Bid plus desired Alternates. The Agency shall have the right to accept Alternates in any order or combination.

- 5.2.2 The Agency reserves the right to waive technicalities, to reject any or all Bids, or any portion thereof, to advertise for new Bids, to proceed to do the Work otherwise, or to abandon the Work, if in the judgment of the Agency or its agent(s), it is in the best interest of the State.
- 5.2.3 An increase or decrease in the quantity for any item is not sufficient grounds for an increase or decrease in the Unit Price.
- 5.2.4 The prices quoted are to be those for which the material will be furnished F.O.B. Job Site and include all charges that may be imposed during the period of the Contract.
- 5.2.5 No qualifying letter or statements in or attached to the Bid, or separate discounts will be considered in determining the low Bid except as may be otherwise herein noted. Cash or separate discounts should be computed and incorporated into Unit Bid Price(s).

### 5.3 DISQUALIFICATION OF BIDDERS

- 5.3.1 An agency shall determine that each Bidder on any Public Works Contract is responsible before awarding the Contract. Factors to be considered in determining the responsibility of a Bidder include:
  - A. The Bidder's financial, physical, personnel or other resources including Subcontracts;
  - B. The Bidder's record of performance on past public or private construction projects, including, but not limited to, defaults and/or final adjudication or admission of violations of the Prevailing Wage Laws in Delaware or any other state;
  - C. The Bidder's written safety plan;
  - D. Whether the Bidder is qualified legally to contract with the State;
  - E. Whether the Bidder supplied all necessary information concerning its responsibility; and,
  - F. Any other specific criteria for a particular procurement, which an agency may establish; provided however, that, the criteria be set forth in the Invitation to Bid and is otherwise in conformity with State and/or Federal law.
- 5.3.2 If an agency determines that a Bidder is nonresponsive and/or nonresponsible, the determination shall be in writing and set forth the basis for the determination. A copy of the determination shall be sent to the affected Bidder within five (5) working days of said determination.
- 5.3.3 In addition, any one or more of the following causes may be considered as sufficient for the disqualification of a Bidder and the rejection of their Bid or Bids.
  - 5.3.3.1 More than one Bid for the same Contract from an individual, firm or corporation under the same or different names.
  - 5.3.3.2 Evidence of collusion among Bidders.
  - 5.3.3.3 Unsatisfactory performance record as evidenced by past experience.
  - 5.3.3.4 If the Unit Prices are obviously unbalanced either in excess or below reasonable cost analysis values.
  - 5.3.3.5 If there are any unauthorized additions, interlineation, conditional or alternate bids or irregularities of any kind which may tend to make the Bid incomplete, indefinite or ambiguous as to its meaning.

- 5.3.3.6 If the Bid is not accompanied by the required Bid Security and other data required by the Bidding Documents.
- 5.3.3.7 If any exceptions or qualifications of the Bid are noted on the Bid Form.
- 5.4 ACCEPTANCE OF BID AND AWARD OF CONTRACT
- 5.4.1 A formal Contract shall be executed with the successful Bidder within twenty (20) calendar days after the award of the Contract.
- 5.4.2 Per Section 6962(d)(13) a., Title 29, Delaware Code, "The contracting agency shall award any public works contract within thirty (30) days of the bid opening to the lowest responsive and responsible Bidder, unless the Agency elects to award on the basis of best value, in which case the election to award on the basis of best value shall be stated in the Invitation To Bid."
- 5.4.3 Each Bid on any Public Works Contract must be deemed responsive by the Agency to be considered for award. A responsive Bid shall conform in all material respects to the requirements and criteria set forth in the Contract Documents and specifications.
- 5.4.4 The Agency shall have the right to accept Alternates in any order or combination, and to determine the low Bidder on the basis of the sum of the Base Bid, plus accepted Alternates.
- 5.4.5 The successful Bidder shall execute a formal contract, submit the required Insurance Certificate, and furnish good and sufficient bonds, unless specifically waived in the General Requirements, in accordance with the General Requirement, within twenty (20) days of official notice of contract award. Bonds shall be for the benefit of the Agency with surety in the amount of 100% of the total contract award. Said Bonds shall be conditioned upon the faithful performance of the contract. Bonds shall remain in affect for period of one year after the date of substantial completion.
- 5.4.6 If the successful Bidder fails to execute the required Contract and Bond, as aforesaid, within twenty (20) calendar days after the date of official Notice of the Award of the Contract, their Bid guaranty shall immediately be taken and become the property of the State for the benefit of the Agency as liquidated damages, and not as a forfeiture or as a penalty. Award will then be made to the next lowest qualified Bidder of the Work or readvertised, as the Agency may decide.
- 5.4.7 Each bidder shall supply with its bid its taxpayer identification number (i.e., federal employer identification number or social security number) and a copy of its Delaware business license, and should the vendor be awarded a contract, such vendor shall provide to the agency the taxpayer identification license numbers of such subcontractors. Such numbers shall be provided on the later of the date on which such subcontractor is required to be identified or the time the contract is executed. The successful Bidder shall provide to the agency to which it is contracting, within 30 days of entering into such public works contract, copies of all Delaware Business licenses of subcontractors and/or independent contractors that will perform work for such public works contract. However, if a subcontractor or independent contractor is hired or contracted more than 20 days after the Bidder entered the public works contract the Delaware Business license of such subcontractor or independent contractor shall be provided to the agency within 10 days of being contracted or hired.
- 5.4.8 The Bid Security shall be returned to the successful Bidder upon the execution of the formal contract. The Bid Securities of unsuccessful bidders shall be returned within thirty (30) calendar days after the opening of the Bids.

## **ARTICLE 6: POST-BID INFORMATION**

### **6.1 CONTRACTOR'S QUALIFICATION STATEMENT**

- 6.1.1 Bidders to whom award of a Contract is under consideration shall, if requested by the Agency, submit a properly executed AIA Document A305, Contractor's Qualification Statement, unless such a statement has been previously required and submitted.

6.2 BUSINESS DESIGNATION FORM

6.2.1 Successful bidder shall be required to accurately complete an Office of Management and Budget Business Designation Form for Subcontractors.

**ARTICLE 7: PERFORMANCE BOND AND PAYMENT BOND**

7.1 BOND REQUIREMENTS

7.1.1 The cost of furnishing the required Bonds, that are stipulated in the Bidding Documents, shall be included in the Bid.

7.1.2 If the Bidder is required by the Agency to secure a bond from other than the Bidder's usual sources, changes in cost will be adjusted as provide in the Contract Documents.

7.1.3 The Performance and Payment Bond forms used shall be the standard OMB forms (attached).

7.2 TIME OF DELIVERY AND FORM OF BONDS

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

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

**ARTICLE 8: FORM OF AGREEMENT BETWEEN AGENCY AND CONTRACTOR**

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

**ARTICLE 9: LIQUIDATED DAMAGES**

9.1 Schedule of Liquidated Damages:

<b>Schedule of Liquidated Damages</b>		
Awarded Contract Value		Daily Charge
For Greater Than	Up to and Including	Calendar Day
\$0.00	\$25,000.00	\$290.00
\$25,000.00	\$50,000.00	\$300.00
\$50,000.00	\$100,000.00	\$400.00
\$100,000.00	\$500,000.00	\$630.00
\$500,000.00	\$1,000,000.00	\$820.00
\$1,000,000.00	\$2,000,000.00	\$1,000.00
\$2,000,000.00	\$5,000,000.00	\$1,060.00
\$5,000,000.00	\$10,000,000.00	\$1,180.00
\$10,000,000.00	\$15,000,000.00	\$1,870.00

\$15,000,000.00	\$20,000,000.00	\$3,130.00
\$20,000,000.00	Over	\$4,360.00

9.2

For each calendar day or work day that work remains uncompleted after the Contract time has expired or beyond the completion date established by the Contract, the sum specified in paragraph 9.1 of this document, will be deducted from any money due the Contractor. This sum shall not be considered and treated as a penalty but as liquidated damages due the University by reason of inconvenience to the public, added cost of engineering and supervision, and other extra expenditures of public funds due to the Contractor's failure to complete the work on time. Any adjustment of the Contract time for completion of the work granted by the University will be considered in the assessment of liquidated damages.

**END OF SECTION 00 21 13**



**BID FORM**

**Project:** FD-15-098 – Education & Humanities Boiler Replacement

**Location:** Delaware State University  
Education & Humanities Building, Main Campus  
1200 N. DuPont Hwy.  
Dover, DE

**For Bids Due:** April 14, 2016 @ 2:00PM

**To:** Delaware State University  
Administration Bldg,  
Purchasing, Room 321  
1200 N. DuPont Highway  
Dover, DE 19901-2277  
Attn: Jessica Wilson  
Director of Purchasing

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

**Delaware Business License No.:** \_\_\_\_\_ **Taxpayer ID No.:** \_\_\_\_\_  
**(A copy of Bidder’s Delaware Business License must be attached to this form.)**

**(Other License Nos.):** \_\_\_\_\_

**Phone No.:** ( ) \_\_\_\_\_ - \_\_\_\_\_ **Fax No.:** ( ) \_\_\_\_\_ - \_\_\_\_\_

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

\$ \_\_\_\_\_ (Written Out).

(\$ \_\_\_\_\_) (Figures).

[This price includes all allowances as documented within the project manual.]

**A. ALTERNATES (Note: project is subject to prevailing wages)**

1. Alternates: Alternate prices conform to applicable project specification section. Refer to the drawing specifications for a complete description of the following Alternates. An “ADD” or “DEDUCT” amount is indicated by the crossing out the part that does not apply.

- a. **Alternate #1:** Extended warranty for the boiler. Net - ADD
  - \_\_\_\_\_ (Figures).
  - \_\_\_\_\_ (Written Out).
  
- b. **Alternate #2:** Cleaning, de-greasing and epoxy finish on the entire boiler room. Net - ADD
  - \_\_\_\_\_ (Figures).
  - \_\_\_\_\_ (Written Out).
  
- c. **Alternate #3:** Net - ADD / DEDUCT
  - \_\_\_\_\_ (Figures).
  - \_\_\_\_\_ (Written Out).

**B. UNIT PRICES**

1. Unit prices conform to applicable project specification section. Refer to the specifications for a complete description of the following Unit Prices:

	<u>ADD</u>	<u>DEDUCT</u>
UNIT PRICE No. 1: _____ (BRIEF DESCRIPTION) _____	\$ _____	\$ _____
UNIT PRICE No. 2: _____ (BRIEF DESCRIPTION) _____	\$ _____	\$ _____
UNIT PRICE No. 3: _____ (BRIEF DESCRIPTION) _____	\$ _____	\$ _____

**C. WORK SCHEDULE**

1. We understand that this contract is governed by liquidated damages and that submission of this bid is acceptance of the proposed contract completion date. Our proposed detailed project schedule shows more fully the sequence of activities necessary to meet the specified schedule. The project schedule is a required attachment of a complete bid and failure to submit a viable schedule will be a justifiable reason to deem the bid as incomplete.
  
2. I/We can begin work \_\_\_\_\_ calendar days after notification of award and will require \_\_\_\_\_ calendar days thereafter to complete the work. Work on the project will begin \_\_\_\_\_ calendar days after Letter of Intent.
  
3. Alternative Work Hours

Work during "regular hours" at this site is being performed on a single shift, eight hours per day, 7:30 AM to 4:30 PM, and five days per week, Monday through Friday. To meet the schedule established on the basis of Item 1 above, our proposed work hours will be \_\_\_\_\_ hours per day, \_\_\_\_\_ AM to \_\_\_\_\_ PM, and \_\_\_\_\_ days per week, \_\_\_\_\_ through \_\_\_\_\_ the cost of which is reflected in our lump sum price. Our lump sum price also includes any mandatory off-hours work required per special conditions.

D. SITE SUPERINTENDANT

We propose to use \_\_\_\_\_ as our site superintendent. A resume of his/her qualifications is attached.

We understand that DSU reserves the right to interview him/her prior to contract award/prior to start of work and to reject him/her if not considered acceptable. If rejected, we will propose alternate personnel for the position who will be subject to the same review and acceptance procedure, at no increase in our lump sum proposal.

We also understand DSU reserves the right to reject our bid if we are unable to provide a site supervisor acceptable to DSU within thirty (30) calendar days after submission of this bid.

E. REMARKS

1. I/We acknowledge Addendums numbered \_\_\_\_\_ and the price(s) submitted include any cost/schedule impact they may have.
2. This bid shall remain valid and cannot be withdrawn for thirty (30) days from the date of opening of bids (60 days for School Districts and Department of Education), and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid.
3. The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.
4. This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.
5. Should I/We be awarded this contract, I/We pledge to achieve substantial completion of all the work within \_\_\_\_\_ calendar days of the Notice to Proceed.
6. Our Bid Price(s) are firm based on contract award within thirty (30) calendar days of the date of submittal of this bid.
7. I/We understand that we will not be compensated at a later date for claimed additional costs based on any information received during the bid period, but which is not identified in our proposal and subsequently accepted in writing by DSU.

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

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

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

By \_\_\_\_\_ Trading as \_\_\_\_\_  
(Individual's / General Partner's / Corporate Name)  
\_\_\_\_\_  
(State of Corporation)

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

**Witness:** \_\_\_\_\_ **By:** \_\_\_\_\_  
(SEAL) ( Authorized Signature )  
\_\_\_\_\_  
( Title )  
**Date:** \_\_\_\_\_

- ATTACHMENTS**  
Sub-Contractor List  
Non-Collusion Statement  
Bid Security  
Construction Schedule  
Resume of Site Superintendent  
(Others as Required by Project Manuals)

**END OF SECTION 00 41 13**

STATE OF DELAWARE  
OFFICE OF MANAGEMENT AND BUDGET

**BID BOND**

TO ACCOMPANY PROPOSAL  
(Not necessary if security is used)

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

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

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

SEALED, AND DELIVERED IN THE  
Presence of

\_\_\_\_\_  
Name of Bidder (Organization)

Corporate  
Seal

By:

\_\_\_\_\_  
Authorized Signature

Attest \_\_\_\_\_

\_\_\_\_\_  
Title

\_\_\_\_\_  
Name of Surety

Witness: \_\_\_\_\_

By:

\_\_\_\_\_  
\_\_\_\_\_  
Title

**SUBCONTRACTOR LIST**

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor **must be listed for each category** where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the *Owner*, **it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.**

<u>Subcontractor Category</u>	<u>Subcontractor</u>	<u>Address (City &amp; State)</u>	<u>Subcontractors tax payer ID # or Delaware Business license #</u>
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____
9. _____	_____	_____	_____

**NON-COLLUSION STATEMENT**

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

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

**NAME OF BIDDER:** \_\_\_\_\_

**AUTHORIZED REPRESENTATIVE  
(TYPED):** \_\_\_\_\_

**AUTHORIZED REPRESENTATIVE  
(SIGNATURE):** \_\_\_\_\_

**TITLE:** \_\_\_\_\_

**ADDRESS OF BIDDER:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**E-MAIL:** \_\_\_\_\_

**PHONE NUMBER:** \_\_\_\_\_

Sworn to and Subscribed before me this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_\_\_\_.

My Commission expires \_\_\_\_\_. NOTARY PUBLIC \_\_\_\_\_.

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

**AFFIDAVIT OF EMPLOYEE DRUG TESTING PROGRAM**

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

For more information, please refer to the following link for the full regulation: <http://regulations.delaware.gov/register/september2015/final/19%20DE%20Reg%20207%2009-01-15.pdf>

All the terms and conditions of *OMB Regulation 4104* have been thoroughly examined and are understood. We hereby certify that we have in place or will implement during the entire term of the contract a Mandatory Drug Testing Program for our employees on the jobsite that complies with this regulation:

**Contractor/Subcontractor Name:** \_\_\_\_\_

**Contractor/Subcontractor Address:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Authorized Representative (typed or printed):** \_\_\_\_\_

**Authorized Representative (signature):** \_\_\_\_\_

**Title:** \_\_\_\_\_

Sworn to and Subscribed before me this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_\_\_\_.

My Commission expires \_\_\_\_\_. NOTARY PUBLIC \_\_\_\_\_.

**AN AFFIDAVIT SHALL BE PROVIDED BY THE BIDDER AND ALL SUBCONTRACTORS IDENTIFIED IN ATTACHED SUBCONTRACTOR LIST. STATEMENT(S) MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.**

**STANDARD FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR A101-2007**

The contract to be utilized on this project shall be the "Standard Form of Agreement Between Owner and Contractor" AIA Document A101-2007.

**END OF SECTION 00 52 13**

## SUPPLEMENT TO AGREEMENT BETWEEN OWNER AND CONTRACTOR A101-2007

The following supplements modify the "Standard Form of Agreement Between Owner and Contractor," AIA Document A101-2007. Where a portion of the Standard Form of Agreement is modified or deleted by the following, the unaltered portions of the Standard Form of Agreement shall remain in effect.

### ARTICLE 5: PAYMENTS

#### 5.1 PROGRESS PAYMENTS

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

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

### ARTICLE 8: MISCELLANEOUS PROVISIONS

#### 8.2 Insert the following:

"Payments are due 30 days after receipt of a valid Application for Payment. After that 30 day period, interest may be charged at the rate of 1% per month not to exceed 12% per annum."

#### 8.5 Delete paragraph 8.5 in its entirety and replace with the following:

"The Contractor's representative shall not be changed without ten days written notice to the Owner."

**END OF SECTION 00 54 13**

STATE OF DELAWARE  
OFFICE OF MANAGEMENT AND BUDGET

**PERFORMANCE BOND**

Bond Number: \_\_\_\_\_

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

Sealed with our seals and dated this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_.

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

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

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

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

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

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

PRINCIPAL

Name: \_\_\_\_\_

Witness or Attest: Address: \_\_\_\_\_

\_\_\_\_\_  
Name:

(Corporate Seal)

By: \_\_\_\_\_ (SEAL)

Name:  
Title:

SURETY

Name: \_\_\_\_\_

Witness or Attest: Address: \_\_\_\_\_

\_\_\_\_\_  
Name:

(Corporate Seal)

By: \_\_\_\_\_ (SEAL)

Name:  
Title:

STATE OF DELAWARE  
OFFICE OF MANAGEMENT AND BUDGET

**PAYMENT BOND**

Bond Number: \_\_\_\_\_

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

Sealed with our seals and dated this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_.

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

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

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

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

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

PRINCIPAL

Name: \_\_\_\_\_

Witness or Attest: Address: \_\_\_\_\_

\_\_\_\_\_  
Name:  
  
(Corporate Seal)

By: \_\_\_\_\_ (SEAL)  
Name:  
Title:

SURETY

Name: \_\_\_\_\_

Witness or Attest: Address: \_\_\_\_\_

\_\_\_\_\_  
Name:  
  
(Corporate Seal)

By: \_\_\_\_\_ (SEAL)  
Name:  
Title:

**APPLICATION AND CERTIFICATION FOR PAYMENT**

AIA DOCUMENT G702

PAGE ONE OF

PAGES

TO OWNER: PROJECT: New Office & Warehouse  
 Owner  
 0000 4th Street  
 Las Vegas, Nv. 00000  
 FROM CONTRACTOR: VIA ARCHITECT:  
 XYZ ELECTRIC Arhitects  
 000 Las Vegas BLVD. 000 Tropicana Blvd.  
 Las Vegas, Nv. 00000 Las Vegas, Nv. 00000  
 CONTRACT FOR: Elect. Systems VIA GENERAL CONTRACTOR: Burke And Associates

APPLICATION NO: 4  
 PERIOD TO: 12/31/99  
 PROJECT NOS: NV000  
 CONTRACT DATE: 08/13/99

Distribution to:  
 OWNER  
 ARCHITECT  
 CONTRACTOR  
 GENERAL CONTRACTOR

**CONTRACTOR'S APPLICATION FOR PAYMENT**

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

1. ORIGINAL CONTRACT SUM	\$	<u>120,693.00</u>
2. Net change by Change Orders	\$	<u>832.16</u>
3. CONTRACT SUM TO DATE (Line 1 ± 2)	\$	<u>121,525.16</u>
4. TOTAL COMPLETED & STORED TO DATE (Column G on G703)	\$	<u>53,064.30</u>
5. RETAINAGE:		
a. % of Completed Work (Column D + E on G703)	\$	<u>5,069.73</u>
b. % of Stored Material (Column F on G703)	\$	<u>236.70</u>
Total Retainage (Lines 5a + 5b or Total in Column I of G703)	\$	<u>5,306.43</u>
6. TOTAL EARNED LESS RETAINAGE (Line 4 Less Line 5 Total)	\$	<u>47,757.87</u>
7. LESS PREVIOUS CERTIFICATES FOR PAYMENT (Line 6 from prior Certificate)	\$	<u>21,970.80</u>
8. CURRENT PAYMENT DUE	\$	<u>25,787.07</u>
9. BALANCE TO FINISH, INCLUDING RETAINAGE (Line 3 less Line 6)	\$	<u>73,767.29</u>

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	\$0.00	
Total approved this Month	\$832.16	
<b>TOTALS</b>	<b>\$832.16</b>	<b>\$0.00</b>
NET CHANGES by Change Order	\$832.16	

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

CONTRACTOR: XYZ ELECTRIC

By: \_\_\_\_\_ Date: 12/31/99  
 President  
 State of: \_\_\_\_\_ County of: \_\_\_\_\_  
 day of \_\_\_\_\_  
 Notary Public:  
 My Commission expires: \_\_\_\_\_

**ARCHITECT'S CERTIFICATE FOR PAYMENT**

In accordance with the Contract Documents, on or about the date of this Certificate, the Architect has received from the Contractor the Application for Payment for the Work covered by this Certificate. The Architect has examined the Application for Payment and the supporting documents, and has determined that the Work has progressed as indicated, the amount of the Work in accordance with the Contract Documents, and the Contractor is entitled to the amount of the Application for Payment.

AMOUNT CERTIFIED \$ \_\_\_\_\_

(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)  
 ARCHITECT:

By: \_\_\_\_\_ Date: \_\_\_\_\_

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



GENERAL CONDITIONS  
TO THE  
CONTRACT

The General Conditions of this Contract are as stated in the American Institute of Architects Document AIA A201 (2007 Edition) entitled General Conditions of the Contract for Construction and is part of this project manual as if herein written in full.

**END OF SECTION 00 72 13**

## SUPPLEMENTARY GENERAL CONDITIONS A201-2007

The following supplements modify the "General Conditions of the Contract for Construction," AIA Document A201-2007. Where a portion of the General Conditions is modified or deleted by the Supplementary Conditions, the unaltered portions of the General Conditions shall remain in effect.

### TABLE OF ARTICLES

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

**ARTICLE 1: GENERAL PROVISIONS**

1.1 BASIC DEFINITIONS

1.1.1 THE CONTRACT DOCUMENTS

Delete the last sentence in its entirety and replace with the following:

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

Add the following Paragraph:

1.1.1.1 In the event of conflict or discrepancies among the Contract Documents, the Documents prepared by the State of Delaware, Division of Facilities Management shall take precedence over all other documents.

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following Paragraphs:

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

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

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

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

Delete Paragraph 1.5.1 in its entirety and replace with the following:

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

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

Delete Paragraph 1.5.2 in its entirety.

**ARTICLE 2: OWNER**

**2.2 INFORMATION AND SERVICES REQUIRED OF THE OWNER**

To Subparagraph 2.2.3 – Add the following sentence:

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

Delete Subparagraph 2.2.5 in its entirety and substitute the following:

2.2.5 The Contractor shall be furnished free of charge up to five (5) sets of the Drawings and Project Manuals. Additional sets will be furnished at the cost of reproduction, postage and handling.

**ARTICLE 3: CONTRACTOR**

**3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR**

Amend Paragraph 3.2.2 to state that any errors, inconsistencies or omissions discovered shall be reported to the Architect and Owner immediately.

Delete the third sentence in Paragraph 3.2.3.

**3.3 SUPERVISION AND CONSTRUCTION PROCEDURES**

Add the following Paragraphs:

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

3.3.4 The Contractor must provide suitable storage facilities at the Site for the proper protection and safe storage of their materials. Consult the Owner and the Architect before storing any materials.

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

**3.4 LABOR AND MATERIALS**

Add the Following Paragraphs:

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

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

3.5 WARRANTY

Add the following Paragraphs:

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

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

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

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

3.11 DOCUMENTS AND SAMPLES AT THE SITE

Add the following Paragraphs:

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

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

3.11.3 The Contractor shall provide two (2) prints of the as-built conditions, along with the reproducible drawings themselves, to the Owner and one (1) set to the Architect. In addition, attach one complete set to each of the Operating and Maintenance Instructions/Manuals.

3.17 In the second sentence of the paragraph, insert "indemnify" between "shall" and "hold".

**ARTICLE 4: ADMINISTRATION OF THE CONTRACT**

4.2 ADMINISTRATION OF THE CONTRACT

Delete the first sentence of Paragraph 4.2.7 and replace with the following:

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

Delete the second sentence of Paragraph 4.2.7 and replace with the following:

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

Add the following Paragraph:

4.2.10.1 There will be no full-time project representative provided by the Owner or Architect on this project.

Add to Paragraph 4.2.13 "and in compliance with all local requirements." to the end of the sentence

## **ARTICLE 5: SUBCONTRACTORS**

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

Delete Paragraph 5.2.3 in its entirety and replace with the following:

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

## **ARTICLE 6: CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS**

### **6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS**

Delete Paragraph 6.1.4 in its entirety.

### **6.2 MUTUAL RESPONSIBILITY**

6.2.3 In the second sentence, strike the word "shall" and insert the word "may".

## **ARTICLE 7: CHANGES IN THE WORK**

(SEE ARTICLE 7: CHANGES IN WORK IN THE GENERAL REQUIREMENTS)

## **ARTICLE 8: TIME**

### **8.2 PROGRESS AND COMPLETION**

Add the following Paragraphs:

8.2.1.1 Refer to Specification Section SUMMARY OF WORK for Contract time requirements.

8.2.4 If the Work falls behind the Progress Schedule as submitted by the Contractor, the Contractor shall employ additional labor and/or equipment necessary to bring the Work into compliance with the Progress Schedule at no additional cost to the Owner.

### **8.3 DELAYS AND EXTENSION OF TIME**

8.3.1 Strike "arbitration" and insert "remedies at law or in equity".

Add the following Paragraph:

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

Delete Paragraph 8.3.3 in its entirety and replace with the following:

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

Add the following Paragraph:

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

## **ARTICLE 9: PAYMENTS AND COMPLETION**

### **9.2 SCHEDULE OF VALUES**

Add the following Paragraphs:

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

9.2.2 The Schedule of Values is to include a line item for Project Closeout Document Submittal. The value of this item is to be no less than 1% of the initial contract amount.

### **9.3 APPLICATIONS FOR PAYMENT**

Add the following Paragraph:

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

Add the following Paragraphs:

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

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

### **9.5 DECISIONS TO WITHHOLD CERTIFICATION**

Add the following to 9.5.1:

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

9.6 PROGRESS PAYMENTS

Delete Paragraph 9.6.1 in its entirety and replace with the following:

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

9.7 FAILURE OF PAYMENT

In first sentence, strike "seven" and insert "thirty (30)". Also strike "binding dispute resolution" and insert "remedies at law or in equity".

9.8 SUBSTANTIAL COMPLETION

To Subparagraph 9.8.3 - Add the following sentence:

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

- 9.8.5 In the second sentence, strike "shall" and insert "may".

**ARTICLE 10: PROTECTION OF PERSONS AND PROPERTY**

10.1 SAFETY PRECAUTIONS AND PROGRAMS

Add the following Paragraphs:

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

10.2 SAFETY OF PERSONS AND PROPERTY

Add the following Paragraph:

- 10.2.4.1 As required in the Hazardous Chemical Act of June 1984, all vendors supplying any material that may be defined as hazardous must provide Material Safety Data Sheets for those products. Any chemical product should be considered hazardous if it has a caution warning on the label relating to a potential physical or health hazard, if it is known to be present in the work place, and if employees may be exposed under normal conditions or in foreseeable emergency situations. Material Safety Data Sheets shall be provided directly to the Owner, along with the shipping slips that include those products.

10.3 HAZARDOUS MATERIALS

Delete Paragraph 10.3.3 in its entirety.

Delete Paragraph 10.3.6 in its entirety.

**ARTICLE 11: INSURANCE AND BONDS**

11.1 CONTRACTOR'S LIABILITY INSURANCE

11.1.4 Strike "the Owner" immediately following "(1)" and strike "and (2) the Owner as an additional insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations."

11.2 OWNER'S LIABILITY INSURANCE

Delete Paragraph 11.2 in its entirety.

11.3 PROPERTY INSURANCE

Delete Paragraph 11.3 in its entirety and replace with the following:

11.3 The State will not provide Builder's All Risk Insurance for the Project. The Contractor and all Subcontractors shall provide property coverage for their tools and equipment, as necessary. Any mandatory deductible required by the Contractor's Insurance shall be the responsibility of the Contractor.

11.4 PERFORMANCE BOND AND PAYMENT BOND

11.4.1 Add the following sentence: "The bonds will conform to those forms approved by the Office of Management and Budget."

**ARTICLE 12: UNCOVERING AND CORRECTION OF WORK**

12.2.2 AFTER SUBSTANTIAL COMPLETION

Add the following Paragraph:

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

12.2.2.1 Strike "one" and insert "two".

12.2.2.2 Strike "one" and insert "two".

12.2.2.3 Strike "one" and insert "two".

12.2.5 In second sentence, strike "one" and insert "two".

**ARTICLE 13: MISCELLANEOUS PROVISIONS**

13.1 GOVERNING LAW

Strike “except that, if the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.”

13.6 INTEREST

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

13.7 TIME LIMITS ON CLAIMS

Strike the last sentence.

Add the following Paragraph:

13.8 CONFLICTS WITH FEDERAL STATUTES OR REGULATIONS

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

Add the following Paragraph:

13.9 CLOUD-BASED PROJECT MANAGEMENT SYSTEM

13.9.1 The Contractor is responsible for communicating to the Owner and the Architect using the University’s Cloud-Based Project Management System for the duration of the contract. The Owner will administer the site and shall provide login credentials to the Contractor following contract award.

**ARTICLE 14: TERMINATION OR SUSPENSION OF THE CONTRACT**

14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

Delete Paragraph 14.4.3 in its entirety and replace with the following:

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

**ARTICLE 15: CLAIMS AND DISPUTES**

15.1.2 Throughout the Paragraph strike “21” and insert “45”.

15.1.6 CLAIMS FOR CONSEQUENTIAL DAMAGES

Delete Paragraph 15.1.6 in its entirety.

15.2 INITIAL DECISION

Delete Paragraph 15.2.5 in its entirety and replace with the following:

15.2.5 The Architect will approve or reject Claims by written decision, which shall state the reasons therefore and shall notify the parties of any change in the Contract Sum or

Contract Time or both. The approval or rejection of a Claim by the Architect shall be subject to mediation and other remedies at law or in equity.

Delete Paragraph 15.2.6 and its subparagraphs in their entirety.

15.3 MEDIATION

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

15.3.2 In the first sentence, delete "administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedure in effect on the date of the Agreement," Strike "binding dispute resolution" and insert "remedies at law and in equity".

15.4 ARBITRATION

Delete Paragraph 15.4 and its sub-sections in its entirety.

**END OF SECTION 00 73 13**

## GENERAL REQUIREMENTS

### TABLE OF ARTICLES

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

**ARTICLE 1: GENERAL**

**1.1 CONTRACT DOCUMENTS**

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

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

**1.2 EQUALITY OF EMPLOYMENT OPPORTUNITY ON PUBLIC WORKS**

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

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

**ARTICLE 2: OWNER**

(NO ADDITIONAL GENERAL REQUIREMENTS – SEE SUPPLEMENTARY GENERAL CONDITIONS)

**ARTICLE 3: CONTRACTOR**

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

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

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

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

**ARTICLE 4: ADMINISTRATION OF THE CONTRACT**

- 4.1 CONTRACT SURETY
- 4.1.1 PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND
- 4.1.2 All bonds will be required as follows unless specifically waived elsewhere in the Bidding Documents.
- 4.1.3 Contents of Performance Bonds – The bond shall be in the form approved by the Office of Management and Budget. The bond shall be conditioned upon the faithful compliance and performance by the successful bidder of each and every term and condition of the contract and the

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

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

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

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

#### 4.2 FAILURE TO COMPLY WITH CONTRACT

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

#### 4.3 CONTRACT INSURANCE AND CONTRACT LIABILITY

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

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

#### 4.4 RIGHT TO AUDIT RECORDS

- 4.4.1 The Owner shall have the right to audit the books and records of a Contractor or any Subcontractor under any Contract or Subcontract to the extent that the books and records relate to the performance of the Contract or Subcontract.
- 4.4.2 Said books and records shall be maintained by the Contractor for a period of seven (7) years from the date of final payment under the Prime Contract and by the Subcontractor for a period of seven (7) years from the date of final payment under the Subcontract.

**ARTICLE 5: SUBCONTRACTORS**

**5.1 SUBCONTRACTING REQUIREMENTS**

- 5.1.1 All contracts for the construction, reconstruction, alteration or repair of any public building (not a road, street or highway) shall be subject to the following provisions:
  - 1. A contract shall be awarded only to a Bidder whose Bid is accompanied by a statement containing, for each Subcontractor category, the name and address (city or town and State only – street number and P.O. Box addresses not required) of the subcontractor whose services the Bidder intends to use in performing the Work and providing the material for such Subcontractor category.
  - 2. A Bid will not be accepted nor will an award of any Contract be made to any Bidder which, as the Prime Contractor, has listed itself as the Subcontractor for any Subcontractor unless:
    - A. It has been established to the satisfaction of the awarding Agency that the Bidder has customarily performed the specialty work of such Subcontractor category by artisans regularly employed by the Bidder's firm;
    - B. That the Bidder is duly licensed by the State to engage in such specialty work, if the State requires licenses; and
    - C. That the Bidder is recognized in the industry as a bona fide Subcontractor or Contractor in such specialty work and Subcontractor category.
- 5.1.2 The decision of the awarding Agency as to whether a Bidder who list itself as the Subcontractor for a Subcontractor category shall be final and binding upon all Bidders, and no action of any nature shall lie against any awarding agency or its employees or officers because of its decision in this regard.
- 5.1.3 After such a Contract has been awarded, the successful Bidder shall not substitute another Subcontractor for any Subcontractor whose name was set forth in the statement which accompanied the Bid without the written consent of the awarding Agency.
- 5.1.4 No Agency shall consent to any substitution of Subcontractors unless the Agency is satisfied that the Subcontractor whose name is on the Bidders accompanying statement:
  - A. Is unqualified to perform the work required;
  - B. Has failed to execute a timely reasonable Subcontract;
  - C. Has defaulted in the performance on the portion of the work covered by the Subcontract; or
  - D. Is no longer engaged in such business.

5.1.5 Should a Bidder be awarded a contract, such successful Bidder shall provide to the agency the taxpayer identification license numbers of such subcontractors. Such numbers shall be provided on the later of the date on which such subcontractor is required to be identified or the time the contract is executed. The successful Bidder shall provide to the agency to which it is contracting, within 30 days of entering into such public works contract, copies of all Delaware Business licenses of subcontractors and/or independent contractors that will perform work for such public works contract. However, if a subcontractor or independent contractor is hired or contracted more than 20 days after the Bidder entered the public works contract the Delaware Business license of such subcontractor or independent contractor shall be provided to the agency within 10 days of being contracted or hired.

5.2 PENALTY FOR SUBSTITUTION OF SUBCONTRACTORS

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

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

5.3 ASBESTOS ABATEMENT

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

5.4 STANDARDS OF CONSTRUCTION FOR THE PROTECTION OF THE PHYSICALLY HANDICAPPED

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

5.5 CONTRACT PERFORMANCE

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

**ARTICLE 6: CONSTRUCTION BY OWNER OR SEPARATE CONTRACTORS**

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

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

**ARTICLE 7: CHANGES IN THE WORK**

- 7.1 The Owner, without invalidating the Contract, may order changes in the Work consisting of Additions, Deletions, Modifications or Substitutions, with the Contract Sum and Contract completion date being adjusted accordingly. Such changes in the Work shall be authorized by written Change Order signed by the Professional, as the duly authorized agent, the Contractor and the Owner.
- 7.2 The Contract Sum and Contract Completion Date shall be adjusted only by a fully executed Change Order.
- 7.3 The additional cost, or credit to the Owner resulting from a change in the Work shall be by mutual agreement of the Owner, Contractor and the Architect. In all cases, this cost or credit shall be based on the 'DPE' wages required and the "invoice price" of the materials/equipment needed.
- 7.3.1 "DPE" shall be defined to mean "direct personnel expense". Direct payroll expense includes direct salary plus customary fringe benefits (prevailing wage rates) and documented statutory costs such as workman's compensation insurance, Social Security/Medicare, and unemployment insurance (a maximum multiplier of 1.35 times DPE).
- 7.3.2 "Invoice price" of materials/equipment shall be defined to mean the actual cost of materials and/or equipment that is paid by the Contractor, (or subcontractor), to a material distributor, direct factory vendor, store, material provider, or equipment leasing entity. Rates for equipment that is leased and/or owned by the Contractor or subcontractor(s) shall not exceed those listed in the latest version of the "Means Building Construction Cost Data" publication.
- 7.3.3 In addition to the above, the General Contractor is allowed a fifteen percent (15%) markup for overhead and profit for additional work performed by the General Contractor's own forces. For additional subcontractor work, the Subcontractor is allowed a fifteen (15) percent overhead and profit on change order work above and beyond the direct costs stated previously. To this amount, the General Contractor will be allowed a mark-up not exceeding seven and one half percent (7.5%) on the subcontractors work. These mark-ups shall include all costs including, but not limited to: overhead, profit, bonds, insurance, supervision, etc. No markup is permitted on the work of the subcontractors subcontractor. No additional costs shall be allowed for changes related to the Contractor's onsite superintendent/staff, or project manager, unless a change in the work changes the project duration and is identified by the CPM schedule. There will be no other costs associated with the change order.

**ARTICLE 8: TIME**

- 8.1 Time limits, if any, are as stated in the Project Manual. By executing the Agreement, the Contractor confirms that the stipulated limits are reasonable, and that the Work will be completed within the anticipated time frame.
- 8.2 If progress of the Work is delayed at any time by changes ordered by the Owner, by labor disputes, fire, unusual delay in deliveries, abnormal adverse weather conditions, unavoidable casualties or other causes beyond the Contractor's control, the Contract Time shall be extended for such reasonable time as the Owner may determine.
- 8.3 Any extension of time beyond the date fixed for completion of the construction and acceptance of any part of the Work called for by the Contract, or the occupancy of the building by the Owner, in whole or in part, previous to the completion shall not be deemed a waiver by the Owner of his right to annul or terminate the Contract for abandonment or delay in the matter provided for, nor relieve the Contractor of full responsibility.
- 8.4 **SUSPENSION AND DEBARMENT**
- 8.4.1 Per Section 6962(d)(14), Title 29, Delaware Code, "Any Contractor who fails to perform a public works contract or complete a public works project within the time schedule established by the Agency in the

Invitation To Bid, may be subject to Suspension or Debarment for one or more of the following reasons: a) failure to supply the adequate labor supply ratio for the project; b) inadequate financial resources; or, c) poor performance on the Project.”

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

8.5 RETAINAGE

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

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

**ARTICLE 9: PAYMENTS AND COMPLETION**

9.1 APPLICATION FOR PAYMENT

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

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

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

9.2 PARTIAL PAYMENTS

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

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

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

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

### 9.3 SUBSTANTIAL COMPLETION

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

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

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

### 9.4 FINAL PAYMENT

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

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

9.4.1.2 An acceptable RELEASE OF LIENS,

9.4.1.3 Copies of all applicable warranties,

9.4.1.4 As-built drawings,

9.4.1.5 Operations and Maintenance Manuals,

9.4.1.6 Instruction Manuals,

9.4.1.7 Consent of Surety to final payment.

9.4.1.8 The Owner reserves the right to retain payments, or parts thereof, for its protection until the foregoing conditions have been complied with, defective work corrected and all unsatisfactory conditions remedied.

## ARTICLE 10: PROTECTION OF PERSONS AND PROPERTY

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

**ARTICLE 11: INSURANCE AND BONDS**

- 11.1 The Contractor shall carry all insurance required by law, such as Unemployment Insurance, etc. The Contractor shall carry such insurance coverage as they desire on their own property such as a field office, storage sheds or other structures erected upon the project site that belong to them and for their own use. The Subcontractors involved with this project shall carry whatever insurance protection they consider necessary to cover the loss of any of their personal property, etc.
- 11.2 Upon being awarded the Contract, the Contractor shall obtain a minimum of two (2) copies of all required insurance certificates called for herein, and submit one (1) copy of each certificate, to the Owner, within 20 days of contract award.
- 11.3 Bodily Injury Liability and Property Damage Liability Insurance shall, in addition to the coverage included herein, include coverage for injury to or destruction of any property arising out of the collapse of or structural injury to any building or structure due to demolition work and evidence of these coverages shall be filed with and approved by the Owner.
- 11.4 The Contractor's Property Damage Liability Insurance shall, in addition to the coverage noted herein, include coverage on all real and personal property in their care, custody and control damaged in any way by the Contractor or their Subcontractors during the entire construction period on this project.
- 11.5 Builders Risk (including Standard Extended Coverage Insurance) on the existing building during the entire construction period, shall not be provided by the Contractor under this contract. The Owner shall insure the existing building and all of its contents and all this new alteration work under this

contract during entire construction period for the full insurable value of the entire work at the site. Note, however, that the Contractor and their Subcontractors shall be responsible for insuring building materials (installed and stored) and their tools and equipment whenever in use on the project, against fire damage, theft, vandalism, etc.

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

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

11.7.1 Contractor's Contractual Liability Insurance

Minimum coverage to be:

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

11.7.2 Contractor's Protective Liability Insurance

Minimum coverage to be:

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

11.7.3 Automobile Liability Insurance

Minimum coverage to be:

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

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

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

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

11.7.5.2 Minimum Limit for all employees working at one site.

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

11.7.7 Social Security Liability

- 11.7.7.1 With respect to all persons at any time employed by or on the payroll of the Contractor or performing any work for or on their behalf, or in connection with or arising out of the Contractor's business, the Contractor shall accept full and exclusive liability for the payment of any and all contributions or taxes or unemployment insurance, or old age retirement benefits, pensions or annuities now or hereafter imposed by the Government of the United States and the State or political subdivision thereof, whether the same be measured by wages, salaries or other remuneration paid to such persons or otherwise.
- 11.7.7.2 Upon request, the Contractor shall furnish Owner such information on payrolls or employment records as may be necessary to enable it to fully comply with the law imposing the aforesaid contributions or taxes.
- 11.7.7.3 If the Owner is required by law to and does pay any and/or all of the aforesaid contributions or taxes, the Contractor shall forthwith reimburse the Owner for the entire amount so paid by the Owner.

**ARTICLE 12: UNCOVERING AND CORRECTION OF WORK**

- 12.1 The Contractor shall promptly correct Work rejected by the Owner or failing to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed, and shall correct any Work found to be not in accordance with the requirements of the Contract Documents within a period of two years from the date of Substantial Completion, or by terms of an applicable special warranty required by the Contract Documents. The provisions of this Article apply to work done by Subcontractors as well as to Work done by direct employees of the Contractor.
- 12.2 At any time during the progress of the work, or in any case where the nature of the defects shall be such that it is not expedient to have them corrected, the Owner, at their option, shall have the right to deduct such sum, or sums, of money from the amount of the contract as they consider justified to adjust the difference in value between the defective work and that required under contract including any damage to the structure.

**ARTICLE 13: MISCELLANEOUS PROVISIONS**

- 13.1 CUTTING AND PATCHING
  - 13.1.1 The Contractor shall be responsible for all cutting and patching. The Contractor shall coordinate the work of the various trades involved.
- 13.2 DIMENSIONS
  - 13.2.1 All dimensions shown shall be verified by the Contractor by actual measurements at the project site. Any discrepancies between the drawings and specifications and the existing conditions shall be referred to the Owner for adjustment before any work affected thereby has been performed.
- 13.3 LABORATORY TESTS
  - 13.3.1 Any specified laboratory tests of material and finished articles to be incorporated in the work shall be made by bureaus, laboratories or agencies approved by the Owner and reports of such tests shall be submitted to the Owner. The cost of the testing shall be paid for by the Contractor.
  - 13.3.2 The Contractor shall furnish all sample materials required for these tests and shall deliver same without charge to the testing laboratory or other designated agency when and where directed by the Owner.
- 13.4 ARCHAEOLOGICAL EVIDENCE
  - 13.4.1 Whenever, in the course of construction, any archaeological evidence is encountered on the surface or below the surface of the ground, the Contractor shall notify the authorities of the Delaware Archaeological Board and suspend work in the immediate area for a reasonable time to permit those

authorities, or persons designated by them, to examine the area and ensure the proper removal of the archaeological evidence for suitable preservation in the State Museum.

13.5 GLASS REPLACEMENT AND CLEANING

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

13.6 WARRANTY

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

**ARTICLE 14: TERMINATION OF CONTRACT**

14.1 If the Contractor defaults or persistently fails or neglects to carry out the Work in accordance with the Contract Documents or fails to perform a provision of the Contract, the Owner, after seven days written notice to the Contractor, may make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Contractor. Alternatively, at the Owner's option, and the Owner may terminate the Contract and take possession of the site and of all materials, equipment, tools, and machinery thereon owned by the Contractor and may finish the Work by whatever method the Owner may deem expedient. If the costs of finishing the Work exceed any unpaid compensation due the Contractor, the Contractor shall pay the difference to the Owner.

14.2 "If the continuation of this Agreement is contingent upon the appropriation of adequate state, or federal funds, this Agreement may be terminated on the date beginning on the first fiscal year for which funds are not appropriated or at the exhaustion of the appropriation. The Owner may terminate this Agreement by providing written notice to the parties of such non-appropriation. All payment obligations of the Owner will cease upon the date of termination. Notwithstanding the foregoing, the Owner agrees that it will use its best efforts to obtain approval of necessary funds to continue the Agreement by taking appropriate action to request adequate funds to continue the Agreement."

**END OF SECTION 00 81 13**

**EMPLOYEE DRUG TESTING REPORT FORM**

**Period Ending:** \_\_\_\_\_

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

Project Number: \_\_\_\_\_

Project Name: \_\_\_\_\_

Contractor/Subcontractor Name: \_\_\_\_\_

Contractor/Subcontractor Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

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

Number of Negative Results \_\_\_\_\_ Number of Positive Results \_\_\_\_\_

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

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

Authorized Representative of Contractor/Subcontractor: \_\_\_\_\_  
(signature)

Date: \_\_\_\_\_

**EMPLOYEE DRUG TESTING**  
**REPORT OF POSITIVE RESULTS**

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

Project Number: \_\_\_\_\_

Project Name: \_\_\_\_\_

Contractor/Subcontractor Name: \_\_\_\_\_

Contractor/Subcontractor Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Name of employee with positive test result: \_\_\_\_\_

Last 4 digits of employee SSN: \_\_\_\_\_

Date test results received: \_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

Authorized Representative of Contractor/Subcontractor: \_\_\_\_\_  
(signature)

Date: \_\_\_\_\_

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

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

***DELAWARE STATE UNIVERSITY***

***TECHNICAL  
SPECIFICATIONS  
FOR***

***PROJECT# FD-15-098  
EDUCATION & HUMANITIES BUILDING  
BOILER REPLACEMENT***

***AT  
DELAWARE STATE UNIVERSITY CAMPUS  
1200 N DUPONT HIGHWAY  
DOVER, DELAWARE***

***PREPARED  
BY***



***BID DOCUMENTS  
MARCH 10, 2016***

***DEDC PROJECT # 15P418***

## **TABLE OF CONTENTS**

- A. Specifications for this project are arranged in accordance with the Construction Specification Institute numbering system and format. Section numbering is discontinuous and all numbers not appearing in the Table of Contents are not used for this Project.
- B. DOCUMENTS BOUND HEREWITH

## **DIVISION 00 – PROCUREMENT AND CONTRACT REQUIREMENTS**

### **INTRODUCTORY INFORMATION**

00 01 01 - PROJECT TITLE PAGE  
00 01 10 - TABLE OF CONTENTS  
00 01 15 - LIST OF DRAWING SHEETS

## **DIVISION 01 – GENERAL REQUIREMENTS**

01 10 00 - SUMMARY  
01 30 00 - ADMINISTRATIVE REQUIREMENTS  
01 40 00 – QUALITY REQUIREMENTS  
01 60 00 - PRODUCT REQUIREMENTS  
01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS  
01 78 00 - CLOSEOUT SUBMITTALS  
01 79 00 - DEMONSTRATION AND TRAINING  
01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

## **DIVISION 03 – CONCRETE**

03 30 00 - CAST-IN-PLACE CONCRETE

## **DIVISION 07 – THERMAL AND MOISTURE PROTECTION**

07 84 00 – FIRESTOPPING

## **DIVISION 22 – PLUMBING**

22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT  
22 07 19 – PLUMBING PIPING INSULATION  
22 10 05 – PLUMBING PIPING  
22 10 06 – PLUMBING PIPELINE SPECIALTIES

## **DIVISION 23 – HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)**

23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT  
23 05 19 - METERS AND GAGES FOR HVAC PIPING  
23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT  
23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC  
23 07 19 – HVAC PIPING INSULATION  
23 09 50 - BUILDING AUTOMATION SYSTEM (BAS) GENERAL  
23 09 51 - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS  
23 09 53 - BAS FIELD PANELS  
23 09 54 – BAS COMMUNICATION DEVICES  
23 09 55 - BAS SOFTWARE AND PROGRAMMING

23 09 58 - SEQUENCE OF OPERATION  
23 09 59 - BAS SYSTEM COMMISSIONING  
23 09 69 – VARIABLE FREQUENCY CONTROLLERS  
23 21 13 - HYDRONIC PIPING  
23 21 14 - HYDRONIC SPECIALTIES  
23 21 23 – HYDRONIC PUMPS  
23 51 00 – BREECHING, CHIMNEYS, AND STACKS  
23 52 16 – CONDENSING BOILERS

**DIVISION 26 – ELECTRICAL**

26 05 01 - MINOR ELECTRICAL DEMOLITION  
26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 V AND LESS)  
26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS  
26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS  
26 05 34 - CONDUIT  
26 05 37 - BOXES  
26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS  
26 27 17 - EQUIPMENT WIRING  
26 27 26 - WIRING DEVICES  
26 28 17 - ENCLOSED CIRCUIT BREAKERS  
26 29 12 – ENCLOSED CONTROLLERS  
26 51 00 – INTERIOR LIGHTING

END OF TABLE OF CONTENTS

**LIST OF DRAWING SHEETS**

COVER SHEET

M-0	MECHANICAL – NOTES, LEGENDS, ABBREVIATIONS & SCHEDULES
MD-1	MECHANICAL – DEMOLITION – BOILER ROOM PLAN & HW PIPING DIAGRAM
M-1	MECHANICAL – NEW WORK – BOILER ROOM PLAN & HW PIPING DIAGRAM
M-2	MECHANICAL - CONTROLS
M-3	MECHANICAL – DETAILS & DIAGRAMS
E-0	ELECTRICAL – NOTES, LEGENDS & ABBREVIATIONS
E-1	ELECTRICAL – DEMOLITIONS & NEW WORK – BOILER ROOM

**SECTION 01 10 00**  
**SUMMARY**

**PART 1 GENERAL**

**1.01 PROJECT**

- A. Project Name: DSU E&H Boiler Room Modifications.
- B. Owner's Name: Delaware State University.
- C. The Project consists of the replacement of two (2) boilers with their associated accessories (pumps, ductwork, piping, control valves, etc), two (2) main loop pumps, and one (1) smaller circulation pump. .

**1.02 CONTRACT DESCRIPTION**

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Division 0 - Procurement and Contract Requirements).

**1.03 DESCRIPTION OF WORK**

- A. Plumbing: Alter existing and add new construction.
- B. HVAC: Alter existing and add new construction.
- C. Electrical Power and Lighting: Alter existing and add new construction.

**1.04 OWNER OCCUPANCY**

- A. Delaware State University intends to continue to occupy adjacent portions of the existing building during the entire construction period.
- B. Delaware State University intends to occupy the Project upon Substantial Completion.
- C. Cooperate with Delaware State University to minimize conflict and to facilitate continuation of normal Delaware State University's operations.
- D. Schedule the Work to accommodate Delaware State University occupancy.

**1.05 CONTRACTOR USE OF SITE AND PREMISES**

- A. Provide access to and from site as required by law and by Delaware State University:
  - 1. Emergency Building Exits During Construction: Keep all exits required by code clear and open during construction period; provide temporary exit signs if exit routes are temporarily altered.
  - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- B. Utility Outages and Shutdown:
  - 1. Limit disruption of utility services to hours the building is unoccupied.
  - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Delaware State University and authorities having jurisdiction.
  - 3. Prevent accidental disruption of utility services to other facilities.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**

**SECTION 01 30 00**  
**ADMINISTRATIVE REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Preconstruction meeting.
- B. Progress meetings.
- C. Construction progress schedule.
- D. Progress photographs.
- E. Coordination drawings.
- F. Submittals for review, information, and project closeout.
- G. Number of copies of submittals.
- H. Submittal procedures.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.
- B. Section 01 78 00 - Closeout Submittals: Project record documents.

**1.03 PROJECT COORDINATION**

- A. Project Coordinator: Construction Manager.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.
- C. During construction, coordinate use of site and facilities through the Project Coordinator.
- D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities.
- F. Coordinate field engineering and layout work under instructions of the Project Coordinator.
- G. Make the following types of submittals to DEDC, LLC through the Project Coordinator:
  - 1. Requests for interpretation.
  - 2. Requests for substitution.
  - 3. Shop drawings, product data, and samples.
  - 4. Test and inspection reports.
  - 5. Manufacturer's instructions and field reports.
  - 6. Applications for payment and change order requests.
  - 7. Progress schedules.
  - 8. Coordination drawings.
  - 9. Closeout submittals.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 PRECONSTRUCTION MEETING**

- A. Delaware State University will schedule a meeting after Notice of Award.
- B. Attendance Required:
  - 1. Delaware State University.
  - 2. DEDC, LLC.
  - 3. Contractor.
- C. Agenda:

1. Execution of Delaware State University-Contractor Agreement.
2. Designation of personnel representing the parties to Contract, Contractor, Subcontractors, and DEDC, LLC.
3. Designation of personnel representing the parties to Contract, owner, and DEDC, LLC.
4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
5. Scheduling.

### **3.02 PROGRESS MEETINGS**

- A. Schedule and administer meetings throughout progress of the Work at maximum two week intervals.
- B. DEDC, LLC will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required: Job superintendent, major Subcontractors and suppliers, Delaware State University, DEDC, LLC, as appropriate to agenda topics for each meeting.
- D. Contractor shall provide a 3-week look ahead schedule in writing at each meeting and be prepared to review with attendees.
- E. Agenda:
  1. Review minutes of previous meetings.
  2. Review of Work progress.
  3. Field observations, problems, and decisions.
  4. Identification of problems that impede, or will impede, planned progress.
  5. Review of submittals schedule and status of submittals.
  6. Maintenance of progress schedule.
  7. Review contractor's 3 week look ahead schedule.
  8. Corrective measures to regain projected schedules.
  9. Planned progress during succeeding work period.
  10. Maintenance of quality and work standards.
  11. Effect of proposed changes on progress schedule and coordination.
  12. Other business relating to Work.

### **3.03 CONSTRUCTION PROGRESS SCHEDULE**

- A. If preliminary construction progress schedule requires revision after review, submit revised schedule within 10 days.
- B. Within 20 days after review of preliminary construction progress schedule, submit draft of proposed final schedule for review.
  1. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.
- C. Within 10 days after joint review, submit final schedule.
- D. Submit updated schedule with each Application for Payment.

### **3.04 COORDINATION DRAWINGS**

- A. Provide information required by Project Coordinator for preparation of coordination drawings.

### **3.05 SUBMITTALS FOR REVIEW**

- A. When the following are specified in individual sections, submit them for review:
  1. Product data.
  2. Shop drawings.
  3. Samples for selection.
  4. Samples for verification.
- B. Submit to DEDC, LLC for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed only for aesthetic, color, or finish selection.

- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below .

### **3.06 SUBMITTALS FOR INFORMATION**

- A. When the following are specified in individual sections, submit them for information:
1. Design data.
  2. Certificates.
  3. Test reports.
  4. Inspection reports.
  5. Manufacturer's instructions.
  6. Manufacturer's field reports.
  7. Other types indicated.
- B. Submit for DEDC, LLC's knowledge as contract administrator or for Delaware State University.

### **3.07 SUBMITTALS FOR PROJECT CLOSEOUT**

- A. When the following are specified in individual sections, submit them at project closeout:
1. Project record documents.
  2. Operation and maintenance data.
  3. Warranties.
  4. Bonds.
  5. Other types as indicated.
- B. Submit for Delaware State University's benefit during and after project completion.

### **3.08 NUMBER OF COPIES OF SUBMITTALS**

- A. Documents for Review:
1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies that Contractor requires, plus one copy that will be retained by DEDC, LLC.
  2. Digital PDFs: PDFs shall be properly scaled whenever applicable. Submit documents to all required parties.
- B. Documents for Information: Submit one copy.
- C. Documents for Project Closeout: Make one reproduction of submittal originally reviewed. Submit one extra of submittals for information.
- D. Samples: Submit the number specified in individual specification sections; one of which will be retained by DEDC, LLC.
1. After review, produce duplicates.
  2. Retained samples will not be returned to Contractor unless specifically so stated.

### **3.09 SUBMITTAL PROCEDURES**

- A. Transmit each submittal with a copy of approved submittal form.
- B. Transmit each submittal with approved form.
- C. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- D. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.
- E. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- F. Deliver submittals to DEDC, LLC at business address.
- G. Schedule submittals to expedite the Project, and coordinate submission of related items.
- H. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
- I. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.

- J. Provide space for Contractor and DEDC, LLC review stamps.
- K. When revised for resubmission, identify all changes made since previous submission.
- L. Distribute reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- M. Submittals not requested will not be recognized or processed.

**END OF SECTION**

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

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Control of installation.
- B. Testing and inspection services.
- C. Manufacturers' field services.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

**1.03 REFERENCE STANDARDS**

- A. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation; 2014.

**1.04 SUBMITTALS**

- A. Design Data: Submit for DEDC, LLC's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Delaware State University's information.
- B. Test Reports: After each test/inspection, promptly submit two copies of report to DEDC, LLC and to Contractor.
  - 1. Include:
    - a. Date issued.
    - b. Project title and number.
    - c. Name of inspector.
    - d. Date and time of sampling or inspection.
    - e. Identification of product and specifications section.
    - f. Location in the Project.
    - g. Type of test/inspection.
    - h. Date of test/inspection.
    - i. Results of test/inspection.
    - j. Conformance with Contract Documents.
    - k. When requested by DEDC, LLC, provide interpretation of results.

**1.05 TESTING AND INSPECTION AGENCIES**

- A. Delaware State University will employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 CONTROL OF INSTALLATION**

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from DEDC, LLC before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

- E. Have Work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

### **3.02 TESTING AND INSPECTION**

- A. Testing Agency Duties:
  - 1. Provide qualified personnel at site. Cooperate with DEDC, LLC and Contractor in performance of services.
  - 2. Perform specified sampling and testing of products in accordance with specified standards.
  - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
  - 4. Promptly notify DEDC, LLC and Contractor of observed irregularities or non-conformance of Work or products.
  - 5. Perform additional tests and inspections required by DEDC, LLC.
  - 6. Submit reports of all tests/inspections specified.
- B. Limits on Testing/Inspection Agency Authority:
  - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
  - 2. Agency may not approve or accept any portion of the Work.
  - 3. Agency may not assume any duties of Contractor.
  - 4. Agency has no authority to stop the Work.
- C. Contractor Responsibilities:
  - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
  - 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
  - 3. Provide incidental labor and facilities:
    - a. To provide access to Work to be tested/inspected.
    - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
    - c. To facilitate tests/inspections.
    - d. To provide storage and curing of test samples.
  - 4. Notify DEDC, LLC and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
  - 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
  - 6. Arrange with Delaware State University's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- D. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by DEDC, LLC.
- E. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

### **3.03 MANUFACTURERS' FIELD SERVICES**

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

**3.04 DEFECT ASSESSMENT**

- A. Replace Work or portions of the Work not conforming to specified requirements.
- B. If, in the opinion of DEDC, LLC, it is not practical to remove and replace the Work, DEDC, LLC will direct an appropriate remedy or adjust payment.

**END OF SECTION**

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

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. General product requirements.
- B. Re-use of existing products.
- C. Transportation, handling, storage and protection.
- D. Product option requirements.
- E. Substitution "or Equal" limitations and procedures.
- F. Procedures for Delaware State University-supplied products.
- G. Maintenance materials, including extra materials, spare parts, tools, and software.

**1.02 RELATED REQUIREMENTS**

- A. Document Instructions to Bidders: Product options and substitution procedures prior to bid date.
- B. Section 01 10 00 - Summary:
- C. Section 01 40 00 - Quality Requirements: Product quality monitoring.
- D. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.
- E. Section 01 74 19 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting packaging and substitutions.

**1.03 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 SUBMITTALS**

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
  - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

**PART 2 PRODUCTS**

**2.01 EXISTING PRODUCTS**

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.
- B. Unforeseen historic items encountered remain the property of the Delaware State University; notify Delaware State University promptly upon discovery; protect, remove, handle, and store as directed by Delaware State University.
- C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Delaware State University, or otherwise indicated as to remain the property of the Delaware State University, become the property of the Contractor; remove from site.

- D. Reused Products: Reused products include materials and equipment previously used in this or other construction, salvaged and refurbished as specified.
- E. Specific Products to be Reused: The reuse of certain materials and equipment already existing on the project site is not prohibited.
  - 1. See Section 01 10 00 for list of items required to be salvaged for reuse and relocation.

## **2.02 NEW PRODUCTS**

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. DO NOT USE products having any of the following characteristics:
  - 1. Made using or containing CFC's or HCFC's.
- C. Where all other criteria are met, Contractor shall give preference to products that:
  - 1. If used on interior, have lower emissions, as defined in Section 01 61 16.
  - 2. If wet-applied, have lower VOC content, as defined in Section 01 61 16.
  - 3. Are extracted, harvested, and/or manufactured closer to the location of the project.
  - 4. Have longer documented life span under normal use.
  - 5. Result in less construction waste.
  - 6. Are made of vegetable materials that are rapidly renewable.
  - 7. Have a published GreenScreen Chemical Hazard Analysis.
- D. Provide interchangeable components of the same manufacture for components being replaced.
- E. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Size terminal lugs to NFPA 70, include lugs for terminal box.

## **2.03 PRODUCT OPTIONS**

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with this specification.

## **2.04 MAINTENANCE MATERIALS**

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

## **PART 3 EXECUTION**

### **3.01 SUBSTITUTION PROCEDURES**

- A. The intent of this process is to allow for manufacturers not listed to provide an "Equal" product to DEDC, LLC for review and approval. This process must take place prior to award of bid.
- B. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D. A request for substitution constitutes a representation that the submitter:
  - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
  - 2. Will provide the same warranty for the substitution as for the specified product.
  - 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Delaware State University.
  - 4. Waives claims for additional costs or time extension that may subsequently become apparent.

5. Has investigated proper clearances and working spaces for substituted equipment and waives claims for additional costs or time extension that may subsequently become apparent. These physical differences must be pointed out at the time of the submittal.
- E. Substitution Submittal Procedure:
1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
  2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
  3. The DEDC, LLC will notify Contractor in writing of decision to accept or reject request.

### **3.02 OWNER-SUPPLIED PRODUCTS**

- A. Delaware State University's Responsibilities:
1. Arrange for and deliver Delaware State University reviewed shop drawings, product data, and samples, to Contractor.
  2. Arrange and pay for product delivery to site.
  3. On delivery, inspect products jointly with Contractor.
  4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
  5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
1. Review Delaware State University reviewed shop drawings, product data, and samples.
  2. Receive and unload products at site; inspect for completeness or damage jointly with Delaware State University.
  3. Handle, store, install and finish products.
  4. Repair or replace items damaged after receipt.

### **3.03 TRANSPORTATION AND HANDLING**

- A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- B. Transport and handle products in accordance with manufacturer's instructions.
- C. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

### **3.04 STORAGE AND PROTECTION**

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Prevent contact with material that may cause corrosion, discoloration, or staining.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

**END OF SECTION**

**SECTION 01 70 00**  
**EXECUTION AND CLOSEOUT REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Cleaning and protection.
- F. Starting of systems and equipment.
- G. Demonstration and instruction of Delaware State University personnel.
- H. Closeout procedures, except payment procedures.
- I. General requirements for maintenance service.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 10 00 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.
- B. Section 01 30 00 - Administrative Requirements: Submittals procedures.
- C. Section 01 74 19 - Construction Waste Management and Disposal: Additional procedures for trash/waste removal, recycling, salvage, and reuse.
- D. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties and bonds.
- E. Section 01 91 13 - General Commissioning Requirements: Contractor's responsibilities in regard to commissioning.
- F. Section 07 84 00 - Firestopping.

**1.03 REFERENCE STANDARDS**

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2009.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
  - 1. Structural integrity of any element of Project.
  - 2. Integrity of weather exposed or moisture resistant element.
  - 3. Efficiency, maintenance, or safety of any operational element.
  - 4. Visual qualities of sight exposed elements.
  - 5. Work of Delaware State University or separate Contractor.
  - 6. Include in request:
    - a. Identification of Project.
    - b. Location and description of affected work.
    - c. Necessity for cutting or alteration.
    - d. Description of proposed work and products to be used.
    - e. Effect on work of Delaware State University or separate Contractor.
    - f. Written permission of affected separate Contractor.
    - g. Date and time work will be executed.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

### **1.05 PROJECT CONDITIONS**

- A. Use of explosives is not permitted.
- B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- C. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
  - 1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Delaware State University.
- D. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
  - 1. Outdoors: Limit conduct of especially noisy exterior work to the hours of 8 am to 5 pm.
  - 2. Indoors: Limit conduct of especially noisy interior work to the hours of 6 pm to 7 am.
- E. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

### **1.06 COORDINATION**

- A. See Section 01 10 00 for occupancy-related requirements.
- B. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- C. Notify affected utility companies and comply with their requirements.
- D. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- E. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and clean-up of work of separate sections.
- H. After Delaware State University occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Delaware State University's activities.

## **PART 2 PRODUCTS**

### **2.01 PATCHING MATERIALS**

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

### **3.02 PREPARATION**

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

### **3.03 PREINSTALLATION MEETINGS**

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify DEDC, LLC four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
  - 1. Review conditions of examination, preparation and installation procedures.
  - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to DEDC, LLC, Delaware State University, participants, and those affected by decisions made.

### **3.04 GENERAL INSTALLATION REQUIREMENTS**

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

### **3.05 ALTERATIONS**

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
  - 1. Verify that construction and utility arrangements are as shown.
  - 2. Report discrepancies to DEDC, LLC before disturbing existing installation.
  - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
  - 1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
  - 2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
- C. Remove existing work as indicated and as required to accomplish new work.
  - 1. Remove items indicated on drawings.

2. Relocate items indicated on drawings.
  3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
  4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
  2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
  3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
    - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
    - b. See Section 01 10 00 for other limitations on outages and required notifications.
    - c. Provide temporary connections as required to maintain existing systems in service.
  4. Verify that abandoned services serve only abandoned facilities.
  5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- E. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
  2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
  3. Repair adjacent construction and finishes damaged during removal work.
- F. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
- G. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- H. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
  2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- I. Clean existing systems and equipment.
- J. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- K. Do not begin new construction in alterations areas before demolition is complete.
- L. Comply with all other applicable requirements of this section.

### **3.06 CUTTING AND PATCHING**

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
  1. Complete the work.

2. Fit products together to integrate with other work.
  3. Provide openings for penetration of mechanical, electrical, and other services.
  4. Match work that has been cut to adjacent work.
  5. Repair areas adjacent to cuts to required condition.
  6. Repair new work damaged by subsequent work.
  7. Remove samples of installed work for testing when requested.
  8. Remove and replace defective and non-conforming work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- J. Patching:
1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
  2. Match color, texture, and appearance.
  3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

### **3.07 PROGRESS CLEANING**

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

### **3.08 PROTECTION OF INSTALLED WORK**

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

### **3.09 SYSTEM STARTUP**

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- D. Verify that wiring and support components for equipment are complete and tested.
- E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

### **3.10 DEMONSTRATION AND INSTRUCTION**

- A. See Section 01 79 00 - Demonstration and Training.

### **3.11 ADJUSTING**

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

### **3.12 FINAL CLEANING**

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Clean debris from roofs, gutters, downspouts, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

### **3.13 CLOSEOUT PROCEDURES**

- A. Make submittals that are required by governing or other authorities.
  - 1. Provide copies to DEDC, LLC.
- B. Notify DEDC, LLC when work is considered ready for Substantial Completion.
- C. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for DEDC, LLC's review.
- D. Correct items of work listed in executed Certificates of Substantial Completion and comply with requirements for access to Delaware State University-occupied areas.
- E. Notify DEDC, LLC when work is considered finally complete.
- F. Complete items of work determined by DEDC, LLC's final inspection.

### **3.14 MAINTENANCE**

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Delaware State University.

**END OF SECTION**

**SECTION 01 78 00**  
**CLOSEOUT SUBMITTALS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

**1.02 RELATED REQUIREMENTS**

- A. Division 00 Documents
- B. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- C. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
- D. Individual Product Sections: Specific requirements for operation and maintenance data.
- E. Individual Product Sections: Warranties required for specific products or Work.

**1.03 SUBMITTALS**

- A. Project Record Documents: Submit documents to DEDC, LLC prior to final payment application. The following documents must be submitted:
  - 1. Red line drawings (As-Built)
    - a. One original paper copy
    - b. Two copies of the original.
- B. Electronic Documentation: Submit the electronic documentation on two long duration archival cd storage devices with gold lacquer finish. The following electronic data shall be included on each CD:
  - 1. Scanned copy of the As-Built in PDF format.
  - 2. Revised AutoCAD (release 2007 or later) drawing. Original copy of the AutoCAD file will be provided upon request.
  - 3. Approved project submittals (PDF Format).
  - 4. Operation and Maintenance Data (PDF Format)
- C. Operation and Maintenance Data:
  - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. DEDC, LLC will review draft and return one copy with comments.
  - 2. For equipment, or component parts of equipment put into service during construction and operated by Delaware State University, submit completed documents within ten days after acceptance.
  - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with DEDC, LLC comments. Revise content of all document sets as required prior to final submission.
  - 4. Submit two sets of revised final documents in a 3-ring binder in final form within 10 days after final inspection.
- D. Warranties and Bonds:
  - 1. For equipment or component parts of equipment put into service during construction with Delaware State University's permission, submit documents within 10 days after acceptance.
  - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
  - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 PROJECT RECORD DOCUMENTS**

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
  - 1. Drawings.
  - 2. Addenda.
  - 3. Change Orders and other modifications to the Contract.
  - 4. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Delaware State University.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Record Drawings : Legibly mark each item to record actual construction including:
  - 1. Field changes of dimension and detail.
  - 2. Details not on original Contract drawings.

**3.02 OPERATION AND MAINTENANCE DATA**

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

**3.03 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS**

- A. For Each Item of Equipment and Each System:
  - 1. Description of unit or system, and component parts.
  - 2. Identify function, normal operating characteristics, and limiting conditions.
  - 3. Include performance curves, with engineering data and tests.
  - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

- J. Provide control diagrams by controls manufacturer as installed.
- K. Include test and balancing reports.
- L. Additional Requirements: As specified in individual product specification sections.

### **3.04 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS**

- A. Assemble operation and maintenance data into durable manuals for Delaware State University's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of DEDC, LLC, Consultants, Contractor and subcontractors, with names of responsible parties.
- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

### **3.05 WARRANTIES AND BONDS**

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Delaware State University's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.

**END OF SECTION**

**SECTION 01 79 00**  
**DEMONSTRATION AND TRAINING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.
- B. Training of Delaware State University personnel in operation and maintenance is required for:
  - 1. All software-operated systems.
  - 2. All new systems relating to this project within the mechanical room.
  - 3. Electrical systems and equipment.
  - 4. Items specified in individual product Sections.
- C. Training of Delaware State University personnel in care, cleaning, maintenance, and repair is required for:
  - 1. Items specified in individual product Sections.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Section 01 91 13 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:
  - 1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority.
  - 2. Submit one copy to the Commissioning Authority, not to be returned.
  - 3. Make commissioning submittals on time schedule specified by Commissioning Authority.
  - 4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of overall Training Plan; submit in editable electronic format, Microsoft Word 2003 preferred.
- B. Draft Training Plans: Delaware State University will designate personnel to be trained; tailor training to needs and skill-level of attendees.
  - 1. Submit to DEDC, LLC for transmittal to Delaware State University.
  - 2. Submit to Commissioning Authority for review and inclusion in overall training plan.
  - 3. Submit not less than four weeks prior to start of training.
  - 4. Revise and resubmit until acceptable.
  - 5. Provide an overall schedule showing all training sessions.
  - 6. Include at least the following for each training session:
    - a. Identification, date, time, and duration.
    - b. Description of products and/or systems to be covered.
    - c. Name of firm and person conducting training; include qualifications.
    - d. Intended audience, such as job description.
    - e. Objectives of training and suggested methods of ensuring adequate training.
    - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
    - g. Media to be used, such as slides, hand-outs, etc.
    - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
  - 1. Include applicable portion of O&M manuals.
  - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.

3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Training Reports:
  1. Identification of each training session, date, time, and duration.
  2. Sign-in sheet showing names and job titles of attendees.
  3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
  4. Include Commissioning Authority's formal acceptance of training session.
- E. Video Recordings: Submit digital video recording of each demonstration and training session for Delaware State University's subsequent use.
  1. Format: DVD Disc.
  2. Label each disc and container with session identification and date.

#### **1.04 QUALITY ASSURANCE**

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
  1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
  2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

### **PART 2 PRODUCTS - NOT USED**

### **PART 3 EXECUTION**

#### **3.01 DEMONSTRATION - GENERAL**

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Delaware State University.
- B. Demonstrations conducted during Functional Testing need not be repeated unless Delaware State University personnel training is specified.
- C. Demonstration may be combined with Delaware State University personnel training if applicable.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
  1. Perform demonstrations not less than two weeks prior to Substantial Completion.
  2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
  1. Perform demonstrations not less than two weeks prior to Substantial Completion.

#### **3.02 TRAINING - GENERAL**

- A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. Delaware State University will provide classroom and seating at no cost to Contractor.
- D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Provide training in minimum two hour segments.
- F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of Delaware State University's personnel to be trained; re-schedule training sessions as required by Delaware State University; once schedule has been approved by Delaware State University failure to conduct sessions according to

schedule will be cause for Delaware State University to charge Contractor for personnel "show-up" time.

- H. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
  - 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
  - 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
  - 3. Typical uses of the O&M manuals.
- I. Product- and System-Specific Training:
  - 1. Review the applicable O&M manuals.
  - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
  - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
  - 4. Provide hands-on training on all operational modes possible and preventive maintenance.
  - 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
  - 6. Discuss common troubleshooting problems and solutions.
  - 7. Discuss any peculiarities of equipment installation or operation.
  - 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
  - 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
  - 10. Review spare parts and tools required to be furnished by Contractor.
  - 11. Review spare parts suppliers and sources and procurement procedures.
- J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

**END OF SECTION**

**SECTION 01 91 13**  
**GENERAL COMMISSIONING REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:
  - 1. Verify that the work is installed in accordance with the Contract Documents, the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports are utilized to achieve this.
  - 2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Tests such as manufacturers startup reports, balancing, and site demonstrations executed by the contractor and witnessed by the Commissioning Authority are utilized to achieve this.
  - 3. Verify that operation and maintenance manuals submitted to Delaware State University are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.
  - 4. Verify that the Delaware State University's operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.
- B. The Commissioning Authority is the Delaware State University

**1.02 SCOPE OF COMMISSIONING**

- A. The following are to be commissioned:
- B. HVAC System, including:
  - 1. Major and minor equipment items provided and installed under this project.
  - 2. Piping systems and equipment.
  - 3. Ductwork and accessories.
  - 4. Control system.
  - 5. Variable frequency drives.
- C. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

**1.03 RELATED REQUIREMENTS**

- A. Section 01 70 00 - Execution and Closeout Requirements: General startup requirements.
- B. Section 01 78 00 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.
- C. Section 01 79 00 - Demonstration and Training: Scope and procedures for Delaware State University personnel training.
- D. Section 23 08 00 - Commissioning of HVAC: HVAC control system testing; other requirements.
- E. Section 23 09 59 - BAS System Commissioning

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures, General Requirements:
- B. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority, unless they require review by DEDC, LLC; in that case, submit to DEDC, LLC first.
- C. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.
- D. Product Data: If submittals to DEDC, LLC do not include the following, submit copies as soon as possible:
- E. Product Data: Submit to DEDC, LLC:

1. Manufacturer's product data, cut sheets, and shop drawings.
2. Manufacturer's installation instructions.
3. Startup, operating, and troubleshooting procedures.
4. Fan and pump curves.
5. Factory test reports.
6. Warranty information, including details of Delaware State University's responsibilities in regard to keeping warranties in force.

F. Startup Plans and Reports.

## **PART 2 PRODUCTS**

### **2.01 TEST EQUIPMENT**

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Delaware State University.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
  1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
  2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
  3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Delaware State University; such equipment, tools, and instruments are to become the property of Delaware State University.

## **PART 3 EXECUTION**

### **3.01 STARTUP PLANS AND REPORTS**

- A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 2 weeks prior to startup.
- B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.
- C. Submit directly to the Commissioning Authority and DEDC,LLC.

### **3.02 FUNCTIONAL TESTS**

- A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. Commissioning Authority is responsible for witnessing results of Functional Tests.
- C. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Delaware State University; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor's stated intentions regarding correction.
  1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
  2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.

3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
  4. Contractor shall bear the cost of Delaware State University and Commissioning Authority personnel time witnessing re-testing.
- D. Functional Test Procedures:
1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
  2. Examples of Functional Testing:
    - a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
    - b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.
    - c. Systems are run through all the HVAC control system's sequences of operation and components are verified to be responding as the sequence's state.
    - d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.
- E. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor's responsibility regardless of timing.

### **3.03 TEST PROCEDURES - GENERAL**

- A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- C. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.

### **3.04 OPERATION AND MAINTENANCE MANUALS**

- A. See Section 01 78 00 for additional requirements.
- B. Add design intent documentation furnished by DEDC, LLC to manuals prior to submission to Delaware State University.

**END OF SECTION**

**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Concrete formwork.
- B. Concrete reinforcement.
- C. Miscellaneous concrete elements, including equipment pads.
- D. Concrete curing.

**1.02 REFERENCE STANDARDS**

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International; 2010.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- C. ACI 301 - Specifications for Structural Concrete; American Concrete Institute International; 2010.
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- E. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 2010.
- F. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001 (Reapproved 2008).
- G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2011.
- H. ACI 347 - Guide to Formwork for Concrete; American Concrete Institute International; 2004.
- I. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Billet-Steel Bars for Concrete Reinforcement; 2014.
- J. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.
- K. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2014.
- L. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2010a.
- M. ASTM C150/C150M - Standard Specification for Portland Cement; 2012.
- N. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.
- O. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2012.
- P. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2011.
- Q. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2012.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

**1.04 QUALITY ASSURANCE**

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
  - 1. Maintain one copy of each document on site.
- B. Follow recommendations of ACI 306R when concreting during cold weather.

## **PART 2 PRODUCTS**

### **2.01 FORMWORK**

- A. Formwork Design and Construction: Comply with guidelines of ACI 347 to provide formwork that will produce concrete complying with tolerances of ACI 117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
  - 1. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

### **2.02 REINFORCEMENT**

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 - 60,000 psi.
- B. Reinforcement Accessories:
  - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.

### **2.03 CONCRETE MATERIALS**

- A. Cement: ASTM C150, Type I - Normal Portland type.
  - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
  - 1. Acquire all aggregates for entire project from same source.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Calcined Pozzolan: ASTM C618, Class N.
- E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.

### **2.04 ACCESSORY MATERIALS**

- A. Moisture-Retaining Cover: ASTM C 171; regular curing paper, white curing paper, clear polyethylene, or white polyethylene.

### **2.05 CONCRETE MIX DESIGN**

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of trial mixtures, as specified in ACI 301.
  - 1. For trial mixtures method, employ independent testing agency acceptable to DEDC, LLC for preparing and reporting proposed mix designs.
- C. Normal Weight Concrete:
  - 1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: As scheduled in part 3.09.
  - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
  - 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
  - 4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.

### **2.06 MIXING**

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

### **3.02 PREPARATION**

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

### **3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS**

- A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

### **3.04 PLACING CONCRETE**

- A. Place concrete in accordance with ACI 304R.

### **3.05 CONCRETE FINISHING**

- A. Repair surface defects, including tie holes, immediately after removing formwork.

### **3.06 CURING AND PROTECTION**

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
  - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
  - 2. Final Curing: Begin after initial curing but before surface is dry.
    - a. Moisture-Retaining Cover: Seal in place with waterproof tape or adhesive.

### **3.07 FIELD QUALITY CONTROL**

- A. An independent testing agency will perform field quality control tests.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure four concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

### **3.08 DEFECTIVE CONCRETE**

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the DEDC, LLC. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

### **3.09 SCHEDULE - CONCRETE TYPES AND FINISHES**

- A. Generator Foundation: 4,500 PSI 28 day concrete, form finish with honeycomb filled side surfaces, level float finish top surface.
- B. Conduit Duct Bank: 3,000 PSI 28 day concrete, side surfaces cast against earth or forms, level top surface with red pigment.
- C. Condensing Unit Pad: 4,500 PSI 28 day concrete, form finish with honeycomb exposed side surfaces, level broom finish top surface.

- D. Interior Housekeeping Pads: 4.000 PSI 28 day concrete, form finish with honeycomb filled side surfaces, hard trowel finish top surface.

**END OF SECTION**

**SECTION 07 84 00**  
**FIRESTOPPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 70 00 - Execution and Closeout Requirements: Cutting and patching.

**1.03 REFERENCE STANDARDS**

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- C. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
- D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; [www.aqmd.gov](http://www.aqmd.gov).
- F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

**1.05 QUALITY ASSURANCE**

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
  - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
  - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at [www.icc-es.org](http://www.icc-es.org) will be considered as constituting an acceptable test report.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
  - 1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:
  - 2. With minimum 3 years documented experience installing work of this type.
  - 3. Able to show at least 5 satisfactorily completed projects of comparable size and type.
  - 4. Licensed by authority having jurisdiction.

**PART 2 PRODUCTS**

**2.01 FIRESTOPPING - GENERAL REQUIREMENTS**

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

**2.02 FIRESTOPPING SYSTEMS**

- A. Firestopping: Any material meeting requirements.
  - 1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

### 2.03 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant; conforming to the following:
  - 1. Color: Black, dark gray, or red.
  - 2. Manufacturers:
    - a. A/D Fire Protection Systems Inc: [www.adfire.com](http://www.adfire.com).
    - b. 3M Fire Protection Products: [www.3m.com/firestop](http://www.3m.com/firestop).
    - c. Hilti, Inc: [www.us.hilti.com](http://www.us.hilti.com).
    - d. Specified Technologies, Inc: [www.stifirestop.com](http://www.stifirestop.com).
    - e. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Foam Firestopping: Single component silicone foam compound; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Color: Dark grey.
  - 3. Manufacturers:
    - a. 3M Fire Protection Products: [www.3m.com/firestop](http://www.3m.com/firestop).
    - b. Hilti, Inc: [www.us.hilti.com](http://www.us.hilti.com).
    - c. Specified Technologies, Inc: [www.stifirestop.com](http://www.stifirestop.com).
    - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Color: Dark grey.
  - 3. Manufacturers:
    - a. A/D Fire Protection Systems Inc: [www.adfire.com](http://www.adfire.com).
    - b. USG: [www.usg.com](http://www.usg.com).
    - c. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Manufacturers:
    - a. A/D Fire Protection Systems Inc: [www.adfire.com](http://www.adfire.com).
    - b. Pecora Corporation: [www.pecora.com](http://www.pecora.com).
    - c. Thermafiber, Inc: [www.thermafiber.com](http://www.thermafiber.com).
    - d. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed; conforming to the following:
  - 1. Manufacturers:
    - a. Grace Construction Products: [www.na.graceconstruction.com](http://www.na.graceconstruction.com).
    - b. 3M Fire Protection Products: [www.3m.com/firestop](http://www.3m.com/firestop).
    - c. Hilti, Inc: [www.us.hilti.com](http://www.us.hilti.com).
    - d. Specified Technologies, Inc: [www.stifirestop.com](http://www.stifirestop.com).
    - e. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Intumescent Putty: Compound that expands on exposure to surface heat gain; conforming to the following:
  - 1. Potential Expansion: Minimum 1000 percent.
  - 2. Durability and Longevity: Permanent.
  - 3. Color: Black, dark gray, or red.
  - 4. Manufacturers:
    - a. Grace Construction Products: [www.na.graceconstruction.com](http://www.na.graceconstruction.com).

- b. 3M Fire Protection Products: [www.3m.com/firestop](http://www.3m.com/firestop).
  - c. Hilti, Inc: [www.us.hilti.com](http://www.us.hilti.com).
  - d. Specified Technologies, Inc: [www.stifirestop.com](http://www.stifirestop.com).
  - e. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

#### **3.02 INSTALLATION**

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.

#### **3.03 CLEANING**

- A. Clean adjacent surfaces of firestopping materials.

#### **3.04 PROTECTION**

- A. Protect adjacent surfaces from damage by material installation.

**END OF SECTION**

**SECTION 22 05 53**  
**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.

**1.02 REFERENCE STANDARDS**

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A. Piping: Tags.
- B. Pumps: Nameplates.
- C. Tanks: Nameplates.

**2.02 NAMEPLATES**

- A. Description: Laminated three-layer plastic with engraved letters.
  - 1. Letter Color: White.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: Black.

**2.03 TAGS**

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

**2.04 PIPE MARKERS**

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive for identification materials.

**3.02 INSTALLATION**

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Use tags on piping 3/4 inch diameter and smaller.
  - 1. Identify service, flow direction, and pressure.
  - 2. Install in clear view and align with axis of piping.

3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

**3.03 SCHEDULES**

- A. Domestic Water: Green Background with White Lettering
- B. Hazardous Gases: Yellow Background with Black Lettering
- C. Non-Hazardous Gases: Blue Background with White Lettering

**END OF SECTION**

**SECTION 22 07 19**  
**PLUMBING PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Piping insulation.
- B. Jackets and accessories.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 84 00 - Firestopping.
- B. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

**1.03 REFERENCE STANDARDS**

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2013.
- B. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2012.
- C. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2013.
- F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

**1.07 FIELD CONDITIONS**

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

**PART 2 PRODUCTS**

**2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION**

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

**2.02 GLASS FIBER**

- A. Manufacturers:
  - 1. Knauf Insulation: [www.knaufusa.com](http://www.knaufusa.com).
  - 2. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
  - 3. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  - 4. CertainTeed Corporation; : [www.certainteed.com](http://www.certainteed.com).

5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
  2. Maximum service temperature: 850 degrees F.
  3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
  1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
  2. Maximum service temperature: 650 degrees F.
  3. Maximum moisture absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

### 2.03 JACKETS

- A. PVC Plastic.
  1. Manufacturers:
    - a. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum Service Temperature: 0 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
    - d. Thickness: 10 mil.
    - e. Connections: Brush on welding adhesive.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Glass fiber insulated pipes conveying fluids below ambient temperature:
  1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- D. Glass fiber insulated pipes conveying fluids above ambient temperature:
  1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- E. Inserts and Shields:
  1. Application: Piping 1-1/2 inches diameter or larger.
  2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  3. Insert location: Between support shield and piping and under the finish jacket.
  4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- G. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- H. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- I. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

### **3.03 SCHEDULES**

- A. Plumbing Systems:
  1. Domestic Cold Water:
    - a. Glass Fiber Insulation: 1-1/2" and smaller shall be 1/2" thick.
    - b. Glass Fiber Insulation: 2" and larger shall be 1" thick.
  2. Roof Drainage Above Grade: 1" Thick down to floor

**END OF SECTION**

**SECTION 22 10 05**  
**PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Pipe, pipe fittings, valves, and connections for piping systems.
  - 1. Domestic water.
  - 2. Gas.
  - 3. Flanges, unions, and couplings.
  - 4. Pipe hangers and supports.
  - 5. Valves.
  - 6. Water pressure reducing valves.
  - 7. Relief valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 84 00 - Firestopping.
- B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- D. Section 22 07 19 - Plumbing Piping Insulation.

**1.03 REFERENCE STANDARDS**

- A. ANSI Z21.22 - American National Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems; 1999, and addenda A&B (R2004).
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.
- C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 2011.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.
- F. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; 2012 (ANSI/ASME B31.1).
- G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2014 (ANSI/ASME B31.9).
- H. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2015.
- I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; The American Society of Mechanical Engineers; 2013.
- J. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems; The American Society of Sanitary Engineering; 2009.
- K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
- L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2013.
- N. ASTM B32 - Standard Specification for Solder Metal; 2008.
- O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
- P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.

- Q. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2010.
- R. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2002 (Reapproved 2010).
- S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- T. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; American Water Works Association; 2013.
- U. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- V. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.
- W. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
- X. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- Y. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.
- Z. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.
- AA. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2011.
- AB. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2011.
- AC. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.
- AD. NSF 61 - Drinking Water System Components - Health Effects; 2012.
- AE. NSF 372 - Drinking Water System Components - Lead Content; 2011.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves.
- D. Maintenance Materials: Furnish the following for Delaware State University's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Valve Repacking Kits: One for each type and size of valve.

#### **1.05 QUALITY ASSURANCE**

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

#### **1.06 REGULATORY REQUIREMENTS**

- A. Perform Work in accordance with State of Delaware plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.

- C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### **1.08 FIELD CONDITIONS**

- A. Do not install underground piping when bedding is wet or frozen.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL REQUIREMENTS**

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

#### **2.02 WATER PIPING, ABOVE GRADE**

- A. Copper Tube(Domestic Water 2" and below): ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - 2. Joints: ASTM B32, alloy Sn95 solder.
- B. Steel Pipe (Domestic Water above 2"): ASTM A53/A53M Schedule 40, galvanized, using one of the following joint types:
  - 1. Threaded Joints: ASME B16.4 cast iron fittings
  - 2. Grooved Joints: AWWA C606 grooved pipe, cast iron fittings, and mechanical couplings.

#### **2.03 NATURAL GAS PIPING, ABOVE GRADE**

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
  - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
  - 2. Joints: NFPA 54, threaded or welded to ASME B31.1.

#### **2.04 FLANGES, UNIONS, AND COUPLINGS**

- A. Unions for Pipe Sizes 3 Inches and Under:
  - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
  - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
  - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
  - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
  - 1. Dimensions and Testing: In accordance with AWWA C606.
  - 2. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron, galvanized.
  - 3. Natural Gas Gasket materials: Gaskets for natural gas piping shall be equal to Flexitallic Sigma 500 series.
  - 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
  - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.

#### **2.05 PIPE HANGERS AND SUPPORTS**

- A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
  2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
  3. Trapeze Hangers: Welded steel channel frames attached to structure.
  4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
1. Conform to ASME B31.9.
  2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
  3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
  4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- C. Plumbing Piping - Water:
1. Conform to ASME B31.9.
  2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
  3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
  4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
  5. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
  2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
  3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
  4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
  5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
  6. Manufacturers:
    - a. Powers Fasteners, Inc: [www.powers.com](http://www.powers.com).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.

## 2.06 GATE VALVES

- A. Manufacturers:
1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  2. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
  3. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
  5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. 2 Inches and Larger:
1. MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

## 2.07 BALL VALVES

- A. Manufacturers:
1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  2. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
  3. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
  5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

## 2.08 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:

1. Amtrol Inc; \_\_\_\_\_: www.amtrol.com.
  2. Cla-Val Co; \_\_\_\_\_: www.cla-val.com.
  3. Watts Regulator Company; \_\_\_\_\_: www.wattsregulator.com.
  4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up to 2 Inches:
1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
- C. Over 2 Inches:
1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

## 2.09 RELIEF VALVES

- A. Temperature and Pressure Relief:
1. Manufacturers:
    - a. Cla-Val Co; \_\_\_\_\_: www.cla-val.com.
    - b. Henry Technologies; \_\_\_\_\_: www.henrytech.com.
    - c. Watts Regulator Company; \_\_\_\_\_: www.wattsregulator.com.
    - d. Substitutions: See Section 01 60 00 - Product Requirements.
  2. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME BPVC-IV certified and labelled.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

### 3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

### 3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Vent piping within a plenum rated ceiling must meet the code required smoke and flame spread ratings. If the material specified to be used does not meet the 25/50 smoke / flame spread rating it will be the installing contractors responsibility to insulate the portion of this piping within the plenum.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- E. All gas piping to be painted yellow. Refer to Section 09 90 00.
- F. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- G. Group piping whenever practical at common elevations.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.
- I. Provide access where valves and fittings are not exposed.
- J. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- K. Sleeve pipes passing through partitions, walls and floors.
- L. Inserts:

1. Provide inserts for placement in concrete formwork.
  2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- M. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
  2. Support horizontal piping as scheduled.
  3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  4. Place hangers within 12 inches of each horizontal elbow.
  5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  6. Provide copper plated hangers and supports for copper piping.

### 3.04 APPLICATION

- A. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- B. Install globe valves for throttling, bypass, or manual flow control services.
- C. Provide plug valves in natural gas systems for shut-off service.

### 3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

### 3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

### 3.07 SCHEDULES

- A. Pipe Hanger Spacing:
  1. Metal Piping:
    - a. Pipe size: 1/2 inches to 1-1/4 inches:
      - 1) Maximum hanger spacing: 6.5 ft.
      - 2) Hanger rod diameter: 3/8 inches.
    - b. Pipe size: 1-1/2 inches to 2 inches:
      - 1) Maximum hanger spacing: 10 ft.
      - 2) Hanger rod diameter: 3/8 inch.
    - c. Pipe size: 2-1/2 inches to 3 inches:
      - 1) Maximum hanger spacing: 10 ft.

- 2) Hanger rod diameter: 1/2 inch.
- d. Pipe size: 4 inches to 6 inches:
  - 1) Maximum hanger spacing: 10 ft.
  - 2) Hanger rod diameter: 5/8 inch.
- 2. Plastic Piping:
  - a. All Sizes:
    - 1) Maximum hanger spacing: 6 ft.
    - 2) Hanger rod diameter: 3/8 inch.

**END OF SECTION**

**SECTION 22 10 06**  
**PLUMBING PIPING SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Backflow preventers.

**1.02 RELATED REQUIREMENTS**

- A. Section 22 10 05 - Plumbing Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers; 2001 (R2007).

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors, and other appertanences.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept specialties on site in original factory packaging. Inspect for damage.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

**2.02 DRAINS**

- A. Manufacturers:
  - 1. Josam Company: [www.josam.com](http://www.josam.com).
  - 2. Jay R. Smith Manufacturing Company: [www.jayrsmith.com](http://www.jayrsmith.com).
  - 3. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com).
  - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Floor Drain:
  - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

**2.03 BACKFLOW PREVENTERS**

- A. Manufacturers:
  - 1. Watts Regulator Company: [www.wattsregulator.com](http://www.wattsregulator.com).
  - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Reduced Pressure Backflow Preventers:
  - 1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two shut off valves, strainer, and four test cocks.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Install floor cleanouts at elevation to accommodate finished floor.
- D. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- E. Install water hammer arrestors complete with accessible isolation valve on cold water supply piping to flush valve water closets.

**END OF SECTION**

## **SECTION 23 05 13**

### **COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Single phase electric motors.
- B. Three phase electric motors.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

##### **1.03 REFERENCE STANDARDS**

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

##### **1.05 QUALITY ASSURANCE**

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

##### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

##### **1.07 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

#### **PART 2 PRODUCTS**

##### **2.01 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A. Electrical Service:
  - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz (unless otherwise noted).
  - 2. Motors Larger than 1/2 Horsepower: 208 or 480 volts, three phase, 60 Hz.
- B. Construction:

1. Open drip-proof type except where specifically noted otherwise.
  2. Design for continuous operation in 40 degrees C environment.
  3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
  2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

## **2.02 SINGLE PHASE POWER - CAPACITOR START MOTORS**

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

## **2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS**

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- H. Sound Power Levels: To NEMA MG 1.
- I. Motors to be used with AC drives shall be inverter duty rated and shall conform to the following:
  1. All motors used with AC drives shall be equipped with thermostats in the stator windings.
  2. The motor shall meet NEMA MG-1, Part 31 standards.
    - a. 1600 Volt rated magnet wire.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

**END OF SECTION**

**SECTION 23 05 19**  
**METERS AND GAGES FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gages.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 21 13 - Hydronic Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2013.
- B. ASTM E1 - Standard Specification for ASTM Thermometers; 2013.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.

**PART 2 PRODUCTS**

**2.01 PRESSURE GAGES**

- A. Manufacturers:
  - 1. Dwyer Instruments, Inc: [www.dwyer-inst.com](http://www.dwyer-inst.com).
  - 2. Moeller Instrument Co., Inc: [www.moellerinstrument.com](http://www.moellerinstrument.com).
  - 3. Omega Engineering, Inc: [www.omega.com](http://www.omega.com).
  - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
  - 1. Case: Steel with brass bourdon tube.
  - 2. Size: 4-1/2 inch diameter.
  - 3. Mid-Scale Accuracy: One percent.
  - 4. Scale: Psi.

**2.02 PRESSURE GAGE TAPPINGS**

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

**2.03 STEM TYPE THERMOMETERS**

- A. Manufacturers:
  - 1. Dwyer Instruments, Inc: [www.dwyer-inst.com](http://www.dwyer-inst.com).
  - 2. Omega Engineering, Inc: [www.omega.com](http://www.omega.com).
  - 3. Weksler Glass Thermometer Corp: [www.wekslerglass.com](http://www.wekslerglass.com).
  - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with

positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

#### **2.04 THERMOMETER SUPPORTS**

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

#### **2.05 TEST PLUGS**

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

#### **2.06 STATIC PRESSURE GAGES**

- A. Manufacturers:
  1. Dwyer Instruments, Inc: [www.dwyer-inst.com](http://www.dwyer-inst.com).
  2. Omega Engineering, Inc: [www.omega.com](http://www.omega.com).
  3. Weksler Glass Thermometer Corp: [www.wekslerglass.com](http://www.wekslerglass.com).
  4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- G. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- H. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

**END OF SECTION**

**SECTION 23 05 53**  
**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.
- D. Ceiling Tacks

**1.02 REFERENCE STANDARDS**

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A. Control Panels: Nameplates.
- B. Heat Transfer Equipment: Nameplates.
- C. Major Control Components: Nameplates.
- D. Piping: Tags.
- E. Pumps: Nameplates.
- F. Tanks: Nameplates.
- G. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- H. Water Treatment Devices: Nameplates.

**2.02 MANUFACTURERS**

- A. Brady Corporation: [www.bradycorp.com](http://www.bradycorp.com).
- B. Champion America, Inc: [www.Champion-America.com](http://www.Champion-America.com).
- C. Seton Identification Products: [www.seton.com/aec](http://www.seton.com/aec).
- D. Substitutions: See Section 01 60 00 - Product Requirements.

**2.03 NAMEPLATES**

- A. Description: Laminated three-layer plastic with engraved letters.
  - 1. Letter Color: White.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: Black.

**2.04 TAGS**

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

## **2.05 PIPE MARKERS**

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

## **2.06 CEILING TACKS**

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
  - 1. HVAC Equipment: Yellow.
  - 2. Fire Dampers and Smoke Dampers: Red.
  - 3. Heating/Cooling Valves: Blue.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive for identification materials.

### **3.02 INSTALLATION**

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- E. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- F. Identify control panels and major control components outside panels with plastic nameplates.
- G. Identify thermostats relating to terminal boxes or valves with nameplates.
- H. Identify valves in main and branch piping with tags.
- I. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

**END OF SECTION**

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Testing, adjustment, and balancing of new hydronic systems.
- B. Commissioning activities.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 40 00: Employment of testing agency and payment for services.
- B. Section 01 91 13: Commissioning requirements that apply to all types of work.

**1.03 REFERENCE STANDARDS**

- A. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.
- B. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
  - 1. Submit to DEDC, LLC.
  - 2. Include at least the following in the plan:
    - a. List of all water flow, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
    - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    - c. Discussion of what notations and markings will be made on the piping drawings during the process.
    - d. Final test report forms to be used.
    - e. Detailed step-by-step procedures for TAB work for each system and issue, including:
      - 1) Flow calibration.
      - 2) Branch/submain proportioning.
      - 3) Total flow calculations.
      - 4) Rechecking.
      - 5) Diversity issues.
    - f. Expected problems and solutions, etc.
    - g. Details of how TOTAL flow will be determined; for example:
      - 1) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
    - h. Confirmation of understanding of the outside air ventilation criteria under all conditions.
    - i. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
  - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for DEDC, LLC and for inclusion in operating and maintenance manuals.
  - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

6. Include the following on the title page of each report:
  - a. Name of Testing, Adjusting, and Balancing Agency.
  - b. Address of Testing, Adjusting, and Balancing Agency.
  - c. Telephone number of Testing, Adjusting, and Balancing Agency.
  - d. Project name.
  - e. Project location.
  - f. Project Engineer.
  - g. Project Contractor.
  - h. Report date.

## **PART 2 PRODUCTS - NOT USED**

## **PART 3 EXECUTION**

### **3.01 GENERAL REQUIREMENTS**

- A. TAB contractor shall review all of the drawings with special attention to the controls drawings as there is additional instruction on the drawings and sequence of operation as to how balancing shall be performed and what information the controls contractor is required to obtain.
- B. Perform total system balance in accordance with one of the following:
  1. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
  2. SMACNA (TAB).
- C. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- D. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- E. TAB Agency Qualifications:
  1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
  2. Certified by one of the following:
    - a. NEBB, National Environmental Balancing Bureau: [www.nebb.org](http://www.nebb.org).
    - b. TABBB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: [www.tabbcertified.org](http://www.tabbcertified.org).
- F. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

### **3.02 EXAMINATION**

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  1. Systems are started and operating in a safe and normal condition.
  2. Temperature control systems are installed complete and operable.
  3. Proper thermal overload protection is in place for electrical equipment.
  4. Duct systems are clean of debris.
  5. Air outlets are installed and connected.
  6. Duct system leakage is minimized.
  7. Hydronic systems are flushed, filled, and vented.
  8. Pumps are rotating correctly.
  9. Proper strainer baskets are clean and in place.
  10. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

### **3.03 PREPARATION**

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
  1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to DEDC, LLC to facilitate spot checks during testing.

### **3.04 ADJUSTMENT TOLERANCES**

- A. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

### **3.05 RECORDING AND ADJUSTING**

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

### **3.06 WATER SYSTEM PROCEDURE**

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

### **3.07 COMMISSIONING**

- A. See Section 01 91 13 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Commissioning Authority Shall be the Owner's Rep.
- D. Fill out Prefunctional Checklists for:
  - 1. Water side systems.
- E. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- F. Re-check a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
  - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
  - 2. Use the same test instruments as used in the original TAB work.
  - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
  - 4. For purposes of re-check, failure is defined as follows:
    - a. Temperatures: Deviation of more than one degree F.
    - b. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
    - c. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
  - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system

served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

- G. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
  2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
  3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

### 3.08 SCOPE

- A. Test, adjust, and balance the following:
1. Boilers
  2. Plumbing Pumps
  3. Boiler Feedwater Pumps

### 3.09 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
1. Manufacturer
  2. Model/Frame
  3. HP/BHP
  4. Phase, voltage, amperage; nameplate, actual, no load
  5. RPM
  6. Service factor
  7. Sheave Make/Size/Bore
- B. V-Belt Drives:
1. Identification/location
  2. Required driven RPM
  3. Driven sheave, diameter and RPM
  4. Belt, size and quantity
  5. Motor sheave diameter and RPM
  6. Center to center distance, maximum, minimum, and actual
- C. Pumps:
1. Identification/number
  2. Manufacturer
  3. Size/model
  4. Impeller
  5. Service
  6. Design flow rate, pressure drop, BHP
  7. Actual flow rate, pressure drop, BHP
  8. Discharge pressure
  9. Suction pressure
  10. Total operating head pressure
- D. Duct Leak Tests:
1. Description of ductwork under test
  2. Duct design operating pressure
  3. Duct design test static pressure

4. Duct capacity, air flow
  5. Maximum allowable leakage duct capacity times leak factor
  6. Test apparatus
    - a. Blower
    - b. Orifice, tube size
    - c. Orifice size
    - d. Calibrated
  7. Test static pressure
  8. Test orifice differential pressure
  9. Leakage
- E. Air Monitoring Stations:
1. Identification/location
  2. System
  3. Size
  4. Area
  5. Design velocity
  6. Design air flow
  7. Test velocity
  8. Test air flow

**END OF SECTION**

**SECTION 23 07 19**  
**HVAC PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Piping insulation.
- B. Jackets and accessories.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 84 00 - Firestopping.
- B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

**1.03 REFERENCE STANDARDS**

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2013.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2013.
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2012.
- F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2013.
- I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

**1.07 FIELD CONDITIONS**

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

**PART 2 PRODUCTS**

**2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION**

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

## 2.02 GLASS FIBER

- A. Manufacturers:
  - 1. Knauf Insulation: [www.knaufusa.com](http://www.knaufusa.com).
  - 2. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
  - 3. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  - 4. CertainTeed Corporation; : [www.certainteed.com](http://www.certainteed.com).
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum service temperature: 850 degrees F.
  - 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
  - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum service temperature: 650 degrees F.
  - 3. Maximum moisture absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

## 2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
  - 1. Armacell LLC: [www.armacell.us](http://www.armacell.us).
  - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
  - 1. Minimum Service Temperature: -40 degrees F.
  - 2. Maximum Service Temperature: 220 degrees F.
  - 3. Connection: Waterproof vapor barrier adhesive.

## 2.04 JACKETS

- A. PVC Plastic.
  - 1. Manufacturers:
    - a. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum Service Temperature: 0 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
    - d. Thickness: 10 mil.
    - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
  - 1. Lagging Adhesive:
    - a. Compatible with insulation.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
  - 1. Thickness: 0.016 inch sheet.
  - 2. Finish: Embossed.
  - 3. Joining: Longitudinal slip joints and 2 inch laps.
  - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
  - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

#### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass fiber insulated pipes conveying fluids below ambient temperature:
  - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Glass fiber insulated pipes conveying fluids above ambient temperature:
  - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
  - 1. Application: Piping 1-1/2 inches diameter or larger.
  - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - 3. Insert location: Between support shield and piping and under the finish jacket.
  - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.
- L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

#### **3.03 SCHEDULE**

- A. Heating Systems:
  - 1. Heating Water Supply and Return: 2" Glass Fiber with PVC plastic fitting covers.
- B. Other Systems:

1. Piping Exposed to Freezing with Heat Tracing: 2" glass fiber with aluminum jacketing

**END OF SECTION**

**SECTION 23 09 50**  
**BUILDING AUTOMATION SYSTEM (BAS) GENERAL**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. General Requirements
- B. Description of Work
- C. Quality Assurance
- D. System Architecture
- E. Distributed Processing Units/Quantity and Location
- F. Demolition and Reuse of Existing Materials and Equipment
- G. Sequence of Work

**1.02 RELATED DOCUMENTS**

- A. Section 23 09 69 - Variable Frequency Controllers
- B. Section 23 09 51 - Building Automation System (BAS) Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 54 - BAS Communication Devices
- E. Section 23 09 55 - BAS Software and Programming
- F. Section 23 09 58 - Sequences of Operation

**1.03 DESCRIPTION OF WORK**

- A. The building automation system (BAS) defined in this specification shall interface with the Delaware State University Network , and shall utilize the BACnet communication requirements as defined by ASHRAE/ANSI 135 (current version and addendum) for all communication.
- B. This system shall be an extension of the existing Johnson Controls System currently installed in this building.

**1.04 APPLICATION OF OPEN PROTOCOLS**

- A. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing BACnet. System components shall communicate using true BacNET in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all building controllers, and all application specific controllers. Gateways to other communication protocols are not acceptable

**1.05 QUALITY ASSURANCE**

- A. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of 2 years since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.  
The following requirement relates to the actual installing contractor.
- B. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years. Firms with experience in BAS installation projects with point counts equal to this project and systems of the same character as this project. If installer is a Value Added Reseller (VAR) of a manufacturer's product, installer must demonstrate at least three years prior experience with that manufacturer's products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.
- C. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than one year from

date of final completion on at least 3 projects of similar size and complexity. Submittals shall document this experience with references.

- D. Installer's Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than 2 projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. The proposed individuals must show proof of the following training:
1. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration
  2. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.
- E. Installer's Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 5 year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.
- F. Installer's Response Time and Proximity
1. Installer must maintain a fully capable service facility within a 45 mile radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
  2. Emergency response times are listed below in this section. Installer must demonstrate the ability to meet the response times.

#### 1.06 CODES AND STANDARDS

- A. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
1. ASHRAE 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. current edition including all related addenda shall apply.
- B. Electronics Industries Alliance
1. EIA-709.1-A-99: Control Network Protocol Specification
  2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
  3. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
  4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
  5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
  6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
  7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
  8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
  9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
- C. Underwriters Laboratories
1. UL 916: Energy Management Systems.  
The following rating is required only for devices used for smoke control purposes. If these are not intended, delete.
  2. UUKL 864: UL Supervised Smoke Control
- D. NEMA Compliance
1. NEMA 250: Enclosure for Electrical Equipment
  2. NEMA ICS 1: General Standards for Industrial Controls.

- E. NFPA Compliance
  - 1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
  - 2. NFPA 70 National Electrical Code (NEC)
- F. Institute of Electrical and Electronics Engineers (IEEE)
  - 1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
  - 2. IEEE 802.3: CSMA/CD (Ethernet - Based) LAN
  - 3. IEEE 802.4: Token Bus Working Group (ARCNET - Based) LAN

### 1.07 DEFINITIONS

- A. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.
- B. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
- C. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications.
- D. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 (Current edition and addendum).
- E. BACnet Interoperability Building Blocks (BIBB): A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
- F. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended opr required destinations.
- G. Building Automation System (BAS): The entire integrated management and control system
- H. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the controlled devices / equipment and the CSS, and temporary data storage for trend information, time schedules, and alarm data.
- I. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135 (current version and addendum)).
- J. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
- K. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
- L. Controller or Control Unit (CU): Intelligent stand-alone control device. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.
- M. Control Systems Server (CSS): A server class computer(s) that maintains the systems configuration and programming database. This server is located within the building as part of the DDC system and serves as an access point to BAS.
- N. Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs, AACs and ASCs. Refer to System Architecture below.
- O. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic
- P. Functional Profile: A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.

- Q. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them.
- R. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
- S. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS
- T. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.
- U. Local Supervisory LAN: Also known as the DSU's Network: Ethernet-based network connecting Primary Controlling LANs with each other and OWSs and CSSs. See System Architecture below.
- V. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard.
- W. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
- X. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.
- Y. Operator Workstation (OWS): The user's interface with the BAS system. As the BAS network devices are stand-alone, dedicated OWS is not required for communications to occur. The OWS can be any computer on DSU's Network that has a compatible Web browser.
- Z. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
- AA. Portable Operators Terminal (POT): Mobile computer used both for direct connection to a controller as well as network connection.
- AB. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135 (current version and addendum)).
- AC. Router: A device that connects two or more networks at the network layer.
- AD. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Controlling LAN. Refer to System Architecture below.
- AE. Server : A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
- AF. Standardized Query Language (SQL): A database computer language designed for managing data in relational database management system (RDBMS). Its scope includes data insert, query, update and delete, schema creation and modification, and data access control.
- AG. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with a controller through the network. This differs from an ASC in that it typically deals only with one variable.
- AH. Extensible Markup Language (XML): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It is a set of rules for encoding documents in machine-readable form that allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

#### **1.08 FUNCTIONAL INTENT**

- A. Throughout Sections 23 09 50 through 23 09 55, the Sequences of Operation, and Section 23 09 59 detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these will only be allowed with prior approval.

## 1.09 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 .
- B. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.
  - 1. Drawings and Diagrams: Shop drawings shall be provided on electronic media as an AutoCAD (current version) and/or Adobe Portable Document Format file. All 'X reference' and font files must be provided with AutoCAD files.
  - 2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format (PDF).
- C. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate item above.
- D. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.
- E. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:
  - 1. System Architecture and System Layout:
    - a. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, instance number, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.
    - b. Provide electronic floor plans locating all control units, workstations, LAN interface devices, gateways, etc. Include all network communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, instance number, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
  - 2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.
  - 3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
  - 4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section 23 09 55 - Part III for additional requirements.
  - 5. Label each control device with setting or adjustable range of control.
  - 6. Label each input and output with the appropriate range.
  - 7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.
  - 8. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
  - 9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block

- numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed.
10. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
  11. Sheets shall be consecutively numbered.
  12. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
  13. Table of Contents listing sheet titles and sheet numbers.
  14. Legend and list of abbreviations.
  15. Memory allocation projections.
  16. Submit along with shop drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.
- F. Open Protocol Information
1. BACnet Systems:
    - a. BACnet object description, object ID, and device ID, for each I/O point.
    - b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
    - c. Submit PICS indicating the BACnet functionality and configuration of each controller.
- G. Framed Control Drawings: Laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.
- H. Control Logic Documentation
1. Submit control logic program listings (for graphical programming) and logic flow charts (for line type programs) to document the control software of all control units.
  2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
  3. Include written description of each control sequence.
  4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.
  5. Sheets shall be consecutively numbered.
  6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
  7. Include Table of Contents listing sheet titles and sheet numbers
  8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Section 01 30 00.
- I. Operation and Maintenance Materials:
1. Submit documents under provisions of Section 01 03 00. One copy of the materials shall be delivered directly to DSU facilities operation staff, in addition to the copies required by other Sections.
  2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
  3. Submit BAS User's Guides (Operating Manuals) for each controller type .
  4. Submit BAS advanced Programming Manuals for each controller type.
  5. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.
- J. Controls contractor shall provide DSU with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers

or branches. This service will be provided for 5 years as part of the contract price, and will be offered to DSU thereafter for the same price as to a dealer or branch.

- K. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance.
- L. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

#### **1.10 PROJECT RECORD DOCUMENTS**

- A. Submit documents under provisions of Section 01 30 00.
- B. Record copies of product data and control shop drawings updated to reflect the final installed condition.
- C. Record copies of approved control logic programming and database on paper and on CD's. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
- D. Record copies of approved project specific graphic software on CDs.
- E. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
- F. Provide record riser diagram showing the location of all controllers.
- G. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

#### **1.11 SYSTEM ARCHITECTURE**

- A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.
- B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.
- C. The system architecture shall consist of the Ethernet-based State Network, and Controlling LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.
  - 1. State Network: Internet-based network connecting multiple facilities with a central data and application server, accessible via standard web-browser. This is an existing infrastructure and contractor is not required to configure any components of this network. Refer to Section 23 09 54 for requirements. This contractor shall integrate the controlling devices and the CCS together.
  - 2. Local Supervisory LAN: The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSS. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power-line carrier communication shall not be acceptable for communications. The physical media will be that installed for the IT infrastructure of the facility and as such network drops will be provided under that scope of work to facilitate work of this scope. This network will be 100 Mbps and therefore all network interface cards shall support that speed. The higher level layers of this network shall be BACnet as described below:
    - a. BACnet Supervisory LAN: Shall be BACnet/IP as defined in the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in the BACnet standard. Point/Object naming conventions are specified in 23 09 55 - Part III.

3. Controlling LAN: High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Acceptable technologies include:
  - a. Ethernet (IEEE802.3)
  - b. ARCNET (IEEE802.4)
  - c. Communication to/from building controller (BC) and the control system server (CSS) shall utilize standard TCP/IP, BACnet/IP ports (80and/or 47808)
4. Secondary Controlling LAN : Network used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.
- D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.
- E. Remote Data Access: The system shall support the following methods of remote access to the building data.
  1. Browser-based access: A remote user using a standard browser shall be able to access all control system facilities and graphics with proper authentication. DSU shall maintain continuous network connection. The following paradigms are acceptable for browser-based access:
    - a. Native Internet-based user interface (HTML, Java, XML, etc.) via a standard freely distributed web browser that does not require a Windows client software installation.
- F. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall recommend reconfiguring the LAN as necessary to accomplish these performance requirements.:
  1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
  2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
  3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at operator workstation.
  4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
  5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
  6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
  7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.
- G. Control Systems Server (CSS): A server class computer(s) that maintains the systems configuration and programming database. This server is located at DSU's data center in a virtual environment and serves as an access point to BAS. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Section 23 09 52 - BAS Operator Interfaces for its requirements.
- H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 23 09 52 - BAS Operator Interfaces.

- I. The BCs, AACs, ASCs, [and SDs] shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 23 09 53 - BAS Field Panels.
- J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on the CSS. User tools provided to DSU shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.
  - 1. Database Schema shall be published and provided to DSU to facilitate easy access to the data.
  - 2. Database shall be ODBC compliant.
- K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.
- L. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
- M. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

#### **1.12 WARRANTY MAINTENANCE**

- A. Contractor shall warrant all products and labor for a period of (2) two years after Substantial Completion.
- B. DSU reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by DSU, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.
- C. At no cost to DSU, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
  - 1. Maintenance services shall be provided for all devices and hardware specified in sections 23 09 51 through 23 09 59 . Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.
  - 2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by DSU to the Contractor.
    - a. Response by telephone to any request for service shall be provided within two (2) hours of DSU's initial telephone request for service.
    - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to DSU's site within eight (8) hours of DSU's initial telephone request for such services, as specified.
  - 3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by DSU to the Contractor.
    - a. Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr per week normal working period) of DSU's initial telephone request for service.
    - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the DSU's site within three (3) working days of the DSU's initial telephone request for such services, as specified.
  - 4. Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for DSU to call in the event of a need for service. At least one of the lines shall

be attended at any given time at all times. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.

5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

### **1.13 DELIVERY, STORAGE, AND HANDLING**

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

### **1.14 LISTING AND LABELING**

- A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS (PRE-APPROVED BY DSU)**

- A. Johnson Controls

### **2.02 MATERIALS AND EQUIPMENT**

- A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

### **2.03 UNIFORMITY**

- A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.
- B. All new controllers installed on the control system network shall be furnished and installed by the BAS contractor.

## **PART 3 - EXECUTION**

### **3.01 INSPECTION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### **3.02 INSTALLATION OF CONTROL SYSTEMS**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Network Connectivity: The BAS contractor shall provide two network connections with Cat-6 cables from the Building Controller to DSU's IT network.
  1. The BAS contractor shall terminate one end of the two Cat-6 cables at or around DSU's patch panel and make connections to DSU's switch with green patch cables, following the instruction of the DFM's IT personnel.
  2. The BAS contractor shall terminate the other end of the two Cat-6 cables near or within the building controller cabinet with dual RJ-45 terminal box and make connection of one cable to the building controller. Note: the second connection is for on-site operator interface through a mobile computer. Exposed cable shall be protected by conduit or wire mold.
  3. The BAS contractor shall label the two network connections BAC-1 and BAC-2 on both ends.
- C. Refer to additional requirements in other sections of this specification.

### 3.03 SURGE PROTECTION

- A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

### 3.04 DEMOLITION AND REUSE OF EXISTING MATERIALS AND EQUIPMENT

- A. Contractor shall assume that existing equipment that specifically is indicated to be reused is in good condition and is operable. Contractor, during the course of work, shall inspect these devices and determine if any devices are in need of replacement or repair. Contractor shall prepare an itemized list of suggested repairs/replacement. This repair/replacement will be at the discretion of DSU and will be accomplished by expanding this contract.
- B. Existing wire, conduit, and control panel cabinets may be reused at DSU Project Engineer's discretion, but only if such materials or equipment comply with the applicable specification for new materials and equipment. Such materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service.
- C. Where such materials are reused, the contractor's shop drawings shall reflect the existing wiring designation. If existing labeling is illegible or otherwise does not comply with the applicable specification for labeling, wiring runs shall be relabeled in accordance with the requirements specified elsewhere.
- D. Existing valves and dampers and their operators may be reused only when preapproved by DSU. Contractor shall lubricate all damper linkages of dampers being controlled under this project.
- E. Other materials and equipment not specifically mentioned herein may be reused only if specifically allowed by indications on the drawings.
- F. For HVAC systems which are indicated to receive a new BAS, all existing materials and equipment associated with the existing pneumatic controls and EMCS shall be removed unless otherwise specified or indicated to remain, or unless reused in accordance with the above requirements, except for the following: 1) conduit and electrical boxes (but not wiring within conduit) may remain in place if not reused (leave a pull line); 2) inaccessible pneumatic tubing may remain in place if not reused. Existing materials and equipment to be removed shall be removed subject to the requirements in paragraph "Sequence of Work". For HVAC systems, which are not to receive a new DDC BAS, the existing pneumatic control system shall remain fully functional.

### 3.05 CONTROL POWER SOURCE AND SUPPLY

- A. Section 23 09 50 Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Sections 23 09 50 through 23 09 55 and Sequences of Operation.
- B. General requirements for obtaining power include the following:
  - 1. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.
  - 2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer
  - 3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and

respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

4. Standalone Functionality: Refer to Section 23 09 53.

### **3.06 BAS STARTUP, COMMISSIONING AND TRAINING**

- A. Refer to Section 23 09 59

### **3.07 SEQUENCE OF OPERATION**

- A. Refer to Section 23 09 58 - Sequences of Operation

**END OF SECTION**

## **SECTION 23 09 51**

### **BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Wiring
- B. Control Valves and Actuators
- C. Control Panels
- D. Sensors
- E. Flow Meter
- F. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)
- G. Transducers
- H. Current Switches
- I. Nameplates
- J. Testing Equipment

##### **1.02 RELATED DOCUMENTS**

- A. Section 23 09 50 - Building Automation System (BAS) General
- B. Section 23 09 53 - BAS Field Panels
- C. Section 23 09 54 - BAS Communications Devices
- D. Section 23 09 55 - BAS Software
- E. Section 23 09 58 - Sequences of Operation
- F. Section 23 09 59 - BAS Commissioning

##### **1.03 DESCRIPTION OF WORK**

- A. Refer to Section 23 09 50 for general requirements.
- B. Refer to other Division 23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.
- C. Provide the following electrical work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
  - 2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
  - 3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
  - 4. All other necessary wiring for fully complete and functional control system as specified.

##### **1.04 WORK BY OTHERS**

- A. Control Valves furnished under this section shall be installed under the applicable piping section under the direction of Section 23 09 51 Contractor who will be fully responsible for the proper operation of the valve.
- B. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of Section 23 09 51 Contractor who will be fully responsible for the proper installation and application.
- C. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120V control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. Section 23 09 51 Contractor shall extend it from the equipment to the control device.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS AND EQUIPMENT**

- A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation and reviewed and approved by DSU. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.
- B. Communication Wiring: All wiring shall be in accordance with National Electrical Codes and Division 26 of this specification.
  - 1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC's, ASC's and local and remote peripherals (e.g., operator workstations, printers, and modems).
  - 2. Local Supervisory LAN: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 6 of standard TIA/EIA (100/1000BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
  - 3. Primary and Secondary roller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.
- C. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes and Division 26 of this Specification.
  - 1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
  - 2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
- D. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification.
  - 1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.
- E. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
  - 1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
  - 2. Provide UL-listed cabinets for use with line voltage devices.
  - 3. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip. Control panel shall have standard manufacturer's color.
  - 4. All gauges and control components shall be identified by means of nameplates.
  - 5. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
  - 6. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

### **2.02 CONTROL VALVES**

- A. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty

actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

B. Plug-Type Globe Pattern for Water Service:

1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
3. Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
4. Temperature Rating: 25°F minimum, 250°F maximum
5. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
6. Valve Trim: Bronze; Stem: Polished stainless steel.
7. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. Plug: Brass, bronze or stainless steel, Seat: Brass
9. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
10. Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
11. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
  - a. Johnson Controls
  - b. Invensys
  - c. Warren
  - d. Delta
  - e. Belimo
  - f. Substitutions: See Section 01 60 00 - Product Requirements.

C. Butterfly Type:

1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
4. Bearings: Bronze or stainless steel
5. Shaft: 416 stainless steel
6. Cold Service Pressure: 175 psi
7. Close Off: Bubble-tight shutoff to 150 psi
8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to DSU.
9. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
  - a. Jamesbury WS815
  - b. Bray Series 31
  - c. Keystone AR2
  - d. Dezurik BGS
  - e. Belimo
  - f. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ball Type

1. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.

2. Seat: Reinforced Teflon
  3. Ball: Stainless steel.
  4. Port: Standard or 'V' style.
  5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
  6. Cold Service Pressure: 600 psi WOG
  7. Steam working Pressure: 150 psi
  8. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    - a. Conbraco
    - b. Worcester
    - c. Nibco
    - d. Jamesbury
    - e. PBM
    - f. Delta
    - g. Belimo
    - h. Substitutions: See Section 01 60 00 - Product Requirements
- E. Segmented or Characterized Ball Type
1. Body: Carbon Steel (ASTM 216), one-piece design with wafer style ends.
  2. Seat: Reinforced Teflon (PTFE).
  3. Ball: Stainless steel ASTM A351
  4. Port: Segmented design with equal-percentage characteristic.
  5. Stem: Stainless steel.
  6. Cold Service Pressure: 200 psi WOG
  7. Cavitation Trim: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
  8. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    - a. Jamesbury R-Series
    - b. Fisher
    - c. Belimo
    - d. Substitutions: See Section 01 60 00 - Product Requirements

### 2.03 ACTUATORS

- A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.
- B. Quarter-Turn Actuators (for ball and butterfly valves):
1. Electric
    - a. Motor: Suitable for 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
    - b. Gear Train. Motor output shall be directed to a self locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
    - c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
    - d. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning.
    - e. Enclosure: Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
    - f. Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.

- g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
- h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
- i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
- j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
- k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
- l. Ambient Conditions: Actuator shall be designed for operation from -140 to 150 °F ambient temperature with 0 to 100 percent relative humidity.

#### **2.04 GENERAL FIELD DEVICES**

- A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.
- B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.
- C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.
- D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.
- E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

#### **2.05 TEMPERATURE SENSORS (TS)**

- A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3°F (0.16 °C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.
- B. Matched Sensors: The following applications shall require matched sensors:
  - 1. Building Loop Connections: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).
  - 2. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.
  - 3. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.
- C. Liquid immersion temperature sensor shall include [Stainless Steel] thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15°F.

1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
  2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.
- D. Pipe Surface-Mount Temperature Sensor: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in paragraph A.
1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
- E. Outside air sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A
1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

## 2.06 TEMPERATURE TRANSMITTERS

- A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

## 2.07 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

- A. General Purpose - Water: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig (3103 KPa) maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range. Acceptable units shall be Kele & Associates Model 360 C. Substitutions shall be allowed per Division 1.
- B. Industrial Application, Liquid, Steam and Gas:
1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
  2. Environmental limits: -40 to 250 °F (-40 to 121°C), 0 to 100% RH..
  3. Accuracy: less than 0.1 percent of span.
  4. Output Damping: Time constant user selectable from 0 to 36 seconds.
  5. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
  6. Electrical Enclosure: NEMA-4, -4X, -7, -9.
  7. Approvals: FM, CSA.
  8. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac. Substitutions shall be allowed per Division 1.

## 2.08 DIFFERENTIAL PRESSURE SWITCHES (DPS)

- A. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 180°F operating temperature range.

## 2.09 TRANSDUCERS

- A. Standard Capacity Electronic-to-Pneumatic (E-P) Transducers: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type, [and Pulse Width Modulated-to-Pneumatic (PWM-P) type]:
1. Electrical Power Supply: 24 Vac or 24 Vdc.
  2. Pneumatic Air Supply: 30 psig (2.07 bar) maximum.
  3. Air Capacity: 1100 scim @ 20 psig (300 cm<sup>3</sup>/sec @ 1.4 bar).
  4. Air Consumption: Zero at steady state.
  5. Output Span: 0-20 psig (0-1.4 bar).

6. Input: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input. [Pulse width modulated or tri-state input shall be allowed].
  7. Pulse Width Modulated and Tri-state Input Time Base: Dip switch selectable
  8. Enclosure: Polymer designed for surface or panel mount.
  9. Air Connections: 1/4" (6.35 mm) barbed.
  10. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
  11. Acceptable Manufacturers: RE Technologies Model UCP-522. Substitutions shall be allowed per Division 1.
- B. Binary to Analog Transducers ([Pulse Width Modulating] or Tri-State-to-Voltage or -Current):
1. Adjustable zero and span.
  2. Failure Mode on Power Loss: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
  3. Accuracy:  $\pm 1\%$  of span
  4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
  5. Input: 4-20 mA, pulse width modulated or tri-state input.
  6. Pulse Width Modulated] and Tri-state Input Time Base: Dip switch selectable.
  7. Enclosure: Polymer designed for surface or panel mount.
  8. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
  9. Acceptable Manufacturers: RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.
- C. Electronic-to Electronic (Voltage or Current to Current or Voltage):
1. Adjustable zero and span.
  2. Failure Mode on Power Loss: Memory feature to allow the transducer to return to last value on power failure.
  3. Accuracy:  $\pm 1\%$  of span.
  4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
  5. Input: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
  6. Pulse Width Modulated] and Tri-state Input Time Base: Dip switch selectable
  7. Enclosure: Polymer enclosure designed for surface or panel mount.
  8. Acceptable Manufacturers: RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.

## 2.10 CURRENT SWITCHES (CS)

- A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
1. Range: 1.5 to 150 amps.
  2. Trip Point: Adjustable.
  3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
  4. Lower Frequency Limit: 6 Hz.
  5. Trip Indication: LED
  6. Approvals: UL, CSA
  7. Max. Cable Size: 350 MCM
  8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED. Substitutions shall be allowed per Division 1.
- B. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150. Substitutions shall be allowed per Division 1.

1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.
- C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
  1. Range: 1.5 to 135 Amps.
  2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
  3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
  4. Frequency Range: 5-75 Hz
  5. Trip Indication: LED
  6. Approvals: UL, CSA
  7. Max. Cable Size: 350 MCM
  8. Acceptable Manufacturers: Veris Industries, Inc. H-904. Substitutions shall be allowed per Division 1.
- D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.
- E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

#### **2.11 CURRENT TRANSFORMERS (CT)**

- A. Clamp-On Design Current Transformer (for Motor Current Sensing)
  1. Range: 1-10 amps minimum, 20-200 amps maximum
  2. Trip Point: Adjustable
  3. Output: 0-5 VDC.
  4. Accuracy:  $\pm 0.2\%$  from 20 to 100 Hz.
  5. Acceptable Manufacturers: KELE SA100. Substitutions shall be allowed per Division 1.

#### **2.12 VENTURI FLOW METER FOR WATER SERVICE**

- A. Flow Sensing Element: Differential-pressure Venturi-type designed for installation in piping.
- B. Construction: Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2" and smaller and flanged or welded for larger than 2".
- C. Differential transmitter shall be dual range industrial grade as specified above.
- D. Connect differential pressure to venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.
- E. Apply Venturi-type flow meters where minimum flow range is no less than 40% of maximum flow.

#### **2.13 ELECTRIC CONTROL COMPONENTS**

- A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.
- B. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure.. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. Coil Enclosure: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
  2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 °F (66 °C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
  3. Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker. Substitutions shall be allowed per Division 1.
  4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).
- C. Low Temperature Detector ('Freezestat') (FZ): Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST ( 4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F (-9.4 to 12.8°C), factory set at 38°F.
- D. High Temperature Detectors ('Firestat') (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F (-4 to 102°C).
- E. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150° F (10 to 65°C) , and a minimum 10°F fixed setpoint differential.
- F. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F (10 to 32°C), switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.
- G. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
    - a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
    - b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
    - c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
    - d. Pilot light indication of power-to-coil and coil retainer clips.
    - e. Coil rated for 50 and 60 Hz service.
    - f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA. Substitutions shall be allowed per Division 1.
    - g. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.
    - h. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
- H. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.
- I. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.
1. Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson. Substitutions shall be allowed per Division 1.
- J. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
  2. TDRs shall be UL and CSA listed, Crouzet type. Substitutions shall be allowed per Division 1.
- K. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.
- L. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.
- M. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory. Substitutions shall be allowed per Division 1.
- N. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

#### **2.14 NAMEPLATES**

- A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.
- B. Each nameplate shall identify the function for each device.

#### **2.15 TESTING EQUIPMENT**

- A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

### **PART 3 - EXECUTION**

#### **3.01 INSPECTION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### **3.02 INSTALLATION OF CONTROL SYSTEMS**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.
- B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.
  1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 16 of this Specification.
  3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
  4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.
  5. Install all control wiring external to panels in electric metallic tubing or raceway. However, communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.
  6. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.
- C. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.
  - D. Freezestats: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips.
  - E. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.
  - F. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.
  - G. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.
  - H. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
  - I. Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.
  - J. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

- K. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
- L. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

**END OF SECTION**

**SECTION 23 09 53**  
**BAS FIELD PANELS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES:**

- A. Building Controller (BC)
- B. Advance Application Specific Controller (AAC)
- C. Application Specific Controller (ASC)

**1.02 RELATED DOCUMENTS:**

- A. Section 23 09 50 - Building Automation System (BAS) General - Refer to this section for definitions of terminology
- B. Section 23 09 51 - BAS Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 54 - BAS Communications Devices
- D. Section 23 09 55 - BAS Software
- E. Section 23 09 58 - Sequence of Operation
- F. Section 23 09 59 - BAS Commissioning

**1.03 DESCRIPTION OF WORK:**

- A. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.
- B. Refer to Section 23 09 50 for general requirements.

**PART 2 - PRODUCTS**

**2.01 STAND-ALONE FUNCTIONALITY**

- A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in Part 3. This item refers to acceptable paradigms for associating the points with the processor.
- B. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.
- C. The following configurations are considered acceptable with reference to a controller's standalone functionality:
  - 1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
  - 2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
  - 3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
  - 4. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices (AACs or ASCs). All wiring to interconnect the I/O expander board shall be:
    - a. Contained in the control panel enclosure;

- b. Or run in conduit. Wiring shall only be accessible at the terminations.
- D. The following configurations are considered unacceptable with reference to a controller's standalone functionality:
  - 1. Multiple controllers enclosed in the same control panel to accomplish the point requirement.

## 2.02 BUILDING CONTROLLER (BC)

- A. General Requirements:
  - 1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.
  - 2. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall be accessed through the CSS in normal operations. In the event that the CSS is not available, the controller shall permit multi-user operation from multiple OWS and mobile computers connected either locally or over the network. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure. BCs shall be programmable from the CSS, OWS, mobile computer, or hand held device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.
  - 3. BCs shall be connected to a controller network that qualifies as a controlling LAN.
  - 4. All BCs shall be provided with a UPS to protect against memory loss and allow for continuous communication with the CSS in the event of a loss of power.
    - a. The UPS shall be a 500 VA UPS equal to APC Back-UPS CS, 300 Watts / 500 VA, Input 120V / Output 120V, Interface Port DB-9 RS-232, USB
  - 5. In addition BCs may provide intelligent, standalone control of BAS functions. Each BC may be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.
  - 6. The BC may provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.
  - 7. All BC point data, algorithms and application software shall be modifiable from the CSS and OWS.
  - 8. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the CSS.
  - 9. BC shall provide buffer for holding alarms, messages, trends etc.
  - 10. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
  - 11. Each BC shall contain software to perform full DDC/PID control loops.
  - 12. For systems requiring end-of-line resistors those resistors shall be located in the BC.
  - 13. Input-Output Processing
    - a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. Each DO shall be discrete

- outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
- b. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10 Vdc, 0-20 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.
  - c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer.
  - d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
  - e. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO [and transducer] is acceptable only with State approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 10 bits.
  - f. Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.
14. A communication port for operator interface through a mobile computer shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting its normal operation.
  15. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the CSS software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.
  16. All analog output points shall have a selectable failure setpoint. The BC shall be capable of maintaining this failure setpoint in the event of a system malfunction, which causes loss of BC control, or loss of output signal, as long as power is available at the BC. The failure setpoint shall be selectable on a per point basis.
  17. Slope intercepts and gain adjustments shall be available on a per-point basis.
  18. BC Power Loss:
    - a. Upon a loss of power to any BC, the other units on the controlling LAN shall not in any way be affected.
    - b. Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours. An alarm diagnostic message shall indicate that the BC is under battery power.
    - c. Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.
    - d. Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network from the CSS or a mobile computer. In addition, DSU shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the

memory of each BC to the CSS or a mobile computer via the network or the local USB or RS-232C port.

19. BC Failure:
    - a. Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either the last value or a specified value. Peer BCs shall recognize the loss and report alarm.
    - b. BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.
  20. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).
  21. BCs may include network communications interface functions for controlling secondary controlling LANs Refer to Section 23 09 54 - BAS System Communications Devices for requirements if this function is packaged with the BC.
  22. A minimum of four levels of privileges shall be provided at each BC.
  23. All local user accounts shall be password protected. Strong password shall be used and complies with DSU's security standard.
  24. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure, as specified elsewhere.
- B. BACnet Building Controller Requirements:
1. The BC(s) shall support all BIBBs defined in the BACnet-IP (B-BC) device profile as defined in the BACnet standard.
  2. BCs shall communicate over the BACnet-IP LAN.
  3. Each BC shall be connected to the BACnet-IP LAN communicating to/from other BCs.

## **2.03 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)**

- A. General Requirements:
1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN. Refer to standalone requirements by application specified in Part 3 of this section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.
  2. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, or LAN Interface Device, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.
  3. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.
  4. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum 8 bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty- (50) hrs with a battery life of (5) five years.
  5. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the OWS.
  6. AAC and ASC Input-Output Processing
    - a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override (Only AAC requires HOA). Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate

- manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
- b. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.
  - c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer
  - d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
  - e. Electronic Analog Outputs (AO) as required by application: voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO [and transducer] is acceptable only with State approval (Generally, PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where PWM is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 8 bits.
- B. BACnet AAC(s) and ASC(s) Requirements:
1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.
  2. AAC(s) and ASC(s) shall communicate over the BACnet Building Controller LAN or the ASC LAN or sub-LAN.
  3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.
- C. Terminal Box Controllers:
1. Terminal box controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. This reset shall be performed while the AHU is operating. The BAS shall send an alarm for any terminal box that has been reset and does not indicate 0 cfm flow with the damper commanded closed.

### **PART 3 - EXECUTION**

#### **3.01 INSPECTION:**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### **3.02 INSTALLATION OF CONTROL SYSTEMS:**

- A. General: Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings. Contractor shall install all controllers in accordance with manufacturer's installation procedures and practices.

#### **3.03 HARDWARE APPLICATION REQUIREMENTS**

- A. General: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control

functions. A BC as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost-effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.

- B. Standalone Capability: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.
- C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.
- D. Application Category 0 (Distributed monitoring)
  - 1. Applications in this category include the following:
    - a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.
    - 2. Points on BCs, AACs, and ASCs may be used in these applications as well as SDs and/or general-purpose I/O modules.
    - 3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
- E. Application Category 1 (Application Specific Controller):
  - 1. Applications in this category include the following:
    - a. Fan Coil Units
    - b. Airflow Control Boxes (VAV and Constant Volume Terminal Units)
    - c. Misc. Heaters
    - d. Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat Pumps)
    - e. Induction Units
    - f. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device.
  - 2. ASCs may be used in these applications.
  - 3. Standalone Capability: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.
    - Physical/Virtual PointDefault Value
    - Scheduling PeriodNormal
    - Morning Warm-UpOff (cold discharge air)
    - Load ShedOff (no shedding)
    - Summer/WinterWinter
    - [Trend DataN/A]
    - [Smoke Pressurization ModeNormal Mode]
  - 4. Mounting:
    - a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure that does not hinder maintenance of mechanical equipment and shall be rated for plenum use.
    - b. ASCs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.

- c. ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the contractor) or in a nearby mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.
      - d. Section 23 09 53 contractor may furnish ASCs to the terminal unit manufacturer for factory mounting.
    5. Programmability: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Application-specific block control algorithms may be used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.
    6. LAN Restrictions: Limit the number of nodes on the network to the maximum recommended by the manufacturer.
  - F. Application Category 2 (General Purpose Terminal Controller)
    1. Applications in this category include the following:
      - a. Unitary Equipment  $\geq$  15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
      - b. Small, Constant Volume Single Zone Air Handling Units
      - c. Constant Volume Pump Start/Stop
      - d. Misc. Equipment (Exhaust Fan) Start/Stop
      - e. Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
      - f. Steam Converter Control
    2. BCs may be used in these applications.
    3. ASC's may be used in these applications provided the ASC meets all requirements specified below. This category requires a general-purpose ASC to which application-specific control algorithms can be attached.
    4. Standalone Capability: Only the following data (as applicable) may be acquired from other ASCs via LANs. In the event of a loss of communications with any other ASCs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC/ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value
Outside Air Temperature	3 minutes	80°F
Outside Air Humidity	3 minutes	60%RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Trend Data	N/A	
Cooling/Heating Requests	3 minutes	None
Smoke Pressurization Mode	3 minutes	Normal Mode
Smoke Exhaust Command	3 minutes	Normal Mode
    5. Mounting:
      - a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment so as not to hinder mechanical maintenance and shall be rated for plenum use.
      - b. ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the contractor) or in a nearby mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.
    6. Programmability: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Operator shall be able to address and configure spare inputs for monitoring. [Operator shall be able to address and configure spare outputs for simple single loop control actions or event initiated actions.] Application-specific block

- control algorithms shall used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.
7. LAN Restrictions: Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 32.
- G. Application Category 3 (Advanced Application Controller)
1. Applications in this category include the following:
    - a. Large Constant Volume Air Handlers
    - b. VAV Air Handlers generally >5,000 and <10,000cfm
    - c. Dual Duct Air Handlers generally >5000 and < 10,000 cfm
    - d. Multizone Air Handlers
    - e. Self-Contained VAV Units
  2. BCs may be used in these applications.
  3. AAC's may be used in these applications provided:
    - a. The AAC's meets all requirements specified below.
    - b. All control functions and physical I/O associated with a given unit resides in one AAC.
    - c. Input A/D is 10-bit. Exception: 8-bit input A/D can be used when matched with high accuracy sensors, the range of which meets the resolution requirements specified for the applicable sensor in Section 23 09 51.
    - d. Pulsed inputs required for the application can be monitored and accumulated effectively.
  4. Standalone Capability: Only the following data (as applicable) may be acquired from other AACs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

physical/virtual point	default delay time	default value
Outside Air Temperature	3 minutes	80°F
Outside Air Humidity	3 minutes	60%RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Enable Local Operation	Last Value	
Cooling/Heating Requests	3 minutes	None
Smoke Pressurization Mode	3 minutes	Normal Mode
Smoke Exhaust Command	3 minutes	Normal Mode
  5. Mounting:
    - a. AACs that control equipment located above accessible ceilings shall be mounted on the equipment so as not to hinder mechanical maintenance and shall be rated for plenum use.
    - b. AACs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the contractor) or in a near by mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.
  6. Programmability: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Operator shall be able to address and configure spare inputs for monitoring. Operator shall be able to program custom DDC control algorithms and specify trending parameters, which will be retained in memory in the event of a loss of communications. Application-specific block control algorithms may be used provided they meet the sequence of operations. The control algorithms shall be completely customizable.
  7. LAN Restrictions: Each LAN which participates in the transfer of data between the CU and the local operator workstation shall be subject to the following criteria:
    - a. Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 16.

- b. The Building Controller LAN shall be subject only to manufacturer's published LAN limitations.
- H. Application Category 4
- 1. Applications in this category include the following:
    - a. Central Cooling Plant
    - b. Central Heating Plant
    - c. Cooling Towers
    - d. Sequenced or Variable Speed Pump Control
    - e. Local Chiller Control (unit specific)
    - f. Local Free Cooling Heat Exchanger Control
    - g. Air Handlers over 10,000 cfm or serving critical areas
  - 2. BCs shall be used in these applications.

### **3.04 CONTROL UNIT REQUIREMENTS**

- A. Refer to Section 23 09 50 for requirements pertaining to control unit quantity and location.

**END OF SECTION**

**SECTION 23 09 54**  
**BAS COMMUNICATION DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Network Integration Devices

**1.02 RELATED DOCUMENTS:**

- A. Section 23 09 50 - Building Automation System (BAS) General
- B. Section 23 09 51 - BAS Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 55 - BAS Software
- E. Section 23 09 58 - Sequences of Operation
- F. Section 23 09 59 - BAS Commissioning

**1.03 DESCRIPTION OF WORK**

- A. Contractor shall provide all interface devices and software to provide an integrated system connecting BCs, AACs, ASCs and Gateways to DSU's network.

**PART 2 - PRODUCTS**

**2.01 NETWORK CONNECTION**

- A. State WAN: Refer Section 23 09 50 Part 1.11.C.1 - Building Automation System (BAS) General for description of System Architecture.
- B. The following BIBBs must be supported on the Local Supervisory LAN using Ethernet either directly or through a gateway:
  - 1. BACnet Data Sharing Objects (DS-):
    - a. Read Property (RP-A) Initiate
    - b. Read Property (RP-B) Execute
    - c. Read Property Multiple (RPM-A) Initiate
    - d. Read Property Multiple (RPM-B) Execute
    - e. Write Property (WP-A) Initiate
    - f. Write Property (WP-B) Execute
    - g. Write Property Multiple (WPM-A) Initiate
    - h. Write Property Multiple (WPM-B) Execute
    - i. COV Unsubscribed (COVU-A) Initiate
    - j. COV Unsubscribed (COVU-B) Execute
  - 2. BACnet Alarm and Event Object (AE-)
    - a. Confirmed Event Notification (N-B) Initiate
    - b. Unconfirmed Event Notification (N-B) Initiate
- C. Refer to Section 23 09 55 Part III for the BACnet Object naming convention.

**2.02 BACNET GATEWAYS**

- A. Gateways shall be provided to link non-BACnet control products to the BACnet inter-network. All of the functionality described in this section is to be provided by using the BACnet capabilities. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.
- B. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified by the AOC using standard BACnet services. All points are required to be writable for each site.
- C. The Gateway shall implement BACnet schedule objects and permit both read and write access to the schedules from the BC.

- D. Each Gateway shall provide a way to collect and archive or trend (time, value) data pairs.
- E. Each Gateway and any devices that the Gateway represents which have time-of-day information shall respond to workstation requests to synchronize the date and time. Each Gateway and any devices that the Gateway represents shall support dynamic device binding and dynamic object binding.
- F. All points in the system shall be made network visible through the use of standard BACnet objects or through proprietary BACnet extensions that the workstation also supports. All points shall be writable using standard BACnet services.
- G. All devices have a Device Object instance number that is unique throughout the entire inter-network. All BACnet devices shall be configured with a Device Object instance number that is based on the format specified (shown in decimal notation). This includes all physical devices as well as any logical BACnet devices that are physically represented by Gateways.
- H. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each true BACnet device or Gateway. The Gateway shall support all BIBBs defined in the BACnet Gateway's device profile as defined in the BACnet standard.

### **2.03 CONTROLLER LOCAL AREA NETWORK INTERFACE DEVICES (LANID)**

- A. The LANID shall be a microprocessor-based communications device which acts as a gateway/router between the Primary Controlling LAN and the Secondary Controlling LAN. It provides an operator interface. These may be provided within a BC or as a separate device.
- B. The LANID shall perform information translation between the Primary Controlling LAN and the Secondary Controlling LAN, supervise communications on a polling Secondary Controlling LAN, and be applicable to systems in which the same functionality is not provided in the BC. In systems where the LANID is a separate device, it shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 09 53. Each LANID shall be mounted in a lockable enclosure.
- C. Each LANID shall support interrogation, full control, and all utilities associated with all BCs on the Primary Controlling LAN, all AACs and ASCs connected to all Secondary Controlling LANs under the Primary Controlling LAN, and all points connected to those PCUs and SCUs.
- D. Upon loss of power to a LANID, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.
- E. The LANID shall be transparent to control functions and shall not be required to control information routing on the Primary Controlling LAN Controlling LAN Controlling LAN Controlling LAN Controlling LAN
- F. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each true BACnet device or Gateway. The Gateway shall support all BIBBs defined in the BACnet Gateway's device profile as defined in the BACnet standard.

### **2.04 LOCAL SUPERVISORY LAN GATEWAYS/ROUTERS**

- A. The gateway/router shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN CSSs or OWS and the Controlling LAN.
- B. The gateway/router shall perform information translation between the Controlling LAN and the Local Supervisory LAN, and shall use BACnet over IP. When BACnet is used, refer to the requirements of the BACnet Gateways specified herein.
- C. The gateway/router shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 09 53. Each gateway/router shall be mounted in a lockable enclosure.
- D. The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the CSS, and OWSs:
  - 1. Configure systems.

2. Monitor and supervise control of all points.
  3. Change control setpoints.
  4. Override input values.
  5. Override output values
  6. Enter programmed start/stop time schedules.
  7. View and acknowledge alarms and messages.
  8. Receive, store and display trend logs and management reports.
  9. Upload/Download programs, databases, etc. as specified.
- E. Upon loss of power to the gateway/router, the battery shall provide for minimum 100 hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.
- F. The gateway/router shall be transparent to control functions and shall not be required to control information routing on the Controlling LAN

### **PART 3 - EXECUTION**

#### **3.01 INSPECTION:**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### **3.02 INSTALLATION OF CONTROL SYSTEMS:**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Contractor shall provide all interface devices and software to provide an integrated system.
- C. Contractor shall closely coordinate with DSU, or designated representative, to establish IP addresses and communications to assure proper operation of the building control system on DSU's network.

**END OF SECTION**

**SECTION 23 09 55**  
**BAS SOFTWARE AND PROGRAMMING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. System Software
- B. Programming Description
- C. Control Algorithms
- D. Energy Management Applications
- E. Password Protection
- F. Alarm Reporting
- G. Trending
- H. Data Acquisition and Storage
- I. Point Structuring
- J. Dynamic Color Graphics

**1.02 RELATED DOCUMENTS:**

- A. Section 23 09 50 - Building Automation System (BAS) General
- B. Section 23 09 51 - BAS Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 54 - BAS Communications Devices
- E. Section 23 09 58 - Sequences of Operation
- F. Section 23 09 59 - BAS Commissioning

**1.03 DESCRIPTION OF WORK:**

- A. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.
- B. Refer to Section 23 09 50 - Building Automation System (BAS) for general requirements
- C. Refer to 23 09 58 - Sequence of Operation for specific sequences of operation for controlled equipment.

**1.04 LICENSING**

- A. Include licensing for all software packages at all required workstations.
- B. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to DSU.
- C. All BAS software should be available on CSS(s) provided, and on all Portable Operator Terminals. All software keys to provide all rights shall be installed on CSS. At least 2 sets of media (CD or DVD) shall be provided with backup software and configurations for all software provided, so that DSU may reinstall any software as necessary
- D. Provide licensing and original software media for each device. Include all BAS software licenses and all required third party software licenses.
- E. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period.
- F. Refer to Section 23 09 50 - Building Automation System (BAS) General for further requirements.

## **PART 2 - PRODUCTS**

### **2.01 SYSTEM SOFTWARE-GENERAL**

- A. **Functionality and Completeness:** The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.
- B. **Configuration:** The software shall support the system as a distributed processing network configuration.

### **2.02 CONTROLLER SOFTWARE**

- A. **BC Software Residency:** Each BC as defined below shall be capable of controlling and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:
  - 1. Real-Time Operating System software
  - 2. Real-Time Clock/Calendar and network time synchronization
  - 3. BC diagnostic software
  - 4. LAN Communication software/firmware
  - 5. Direct Digital Control software
  - 6. Alarm Processing and Buffering software
  - 7. Energy Management software
  - 8. Data Trending, Reporting, and Buffering software
  - 9. I/O (physical and virtual) database
  - 10. Remote Communications software
- B. **AAC/ASC Software Residency:** Each AAC/ASC as defined below shall be capable of controlling and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Section 23 09 54) with the restrictions/exceptions per application provided in Section 23 09 53:
  - 1. Real-Time Operating System software
  - 2. AAC/ASC diagnostic software
  - 3. LAN Communications software
  - 4. Control software applicable to the unit it serves that will support a single mode of operation
  - 5. I/O (physical and virtual) database to support one mode of operation
- C. **Standalone Capability:** BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC, CSS, or other communication links to other BCs/AACs/ASCs or CSSs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 23 09 53 for other aspects of standalone functionality.
- D. **Operating System:** Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Section 23 09 53 for other aspects of the controller's operating system.
- E. **Network Communications:** Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:
  - 1. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
  - 2. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or CSS. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is online and functioning without disruption to unaffected points. The software

architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

- F. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions.
- G. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.
- H. Application Programs: CUs shall support and execute application programs as more fully specified below:
  - 1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) user programming.
- I. Security: Controller software shall support multiple level privileges access restriction as more fully specified below.
- J. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
  - 1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
  - 2. Two Position control (Hi or Low crossing with deadband)
  - 3. Single-Pole Double-Throw relay
  - 4. Delay Timer (delay-on-make, delay-on-break, and interval)
  - 5. Hi/Low Selection
  - 6. Reset or Scaling Module
  - 7. Logical Operators (AND, OR, NOT, XOR)
- K. Psychrometric Parameters: Controller software shall provide preprogrammed functions to calculate and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.
- L. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS using BACnet services connected locally or through the network. Initiation of an upload or download shall include all of the following methods: Manual, Scheduled, and Automatic upon detection of a loss or change.
- M. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail-safe (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.
- N. Time Synchronization: Automatic time synchronization shall be provided using BACnet services. Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously.
- O. Misc. Calculations: System software shall automate calculation of psychrometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

### **2.03 APPLICATION PROGRAMMING DESCRIPTION**

- A. The application software shall be user programmable.
- B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:
  - 1. Point Definition: Provide templates customized for point type, to support input of individual point information. Use standard BACnet Objects as applicable.

2. Graphical Block Programming: Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
  3. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
- C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

#### **2.04 ENERGY MANAGEMENT APPLICATIONS**

- A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:
1. Time-of-Day Scheduling
  2. Calendar-Based Scheduling
  3. Holiday Scheduling
  4. Temporary Schedule Overrides
  5. Optimal Start / Optimal Stop based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
  6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
  7. Economizer Control (enthalpy or dry-bulb)
  8. Peak Demand Limiting / Load Shedding
  9. Dead Band Control
- B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in Section 23 09 58 - Sequence of Operation.

#### **2.05 ACCESS PRIVILEGES**

- A. Multiple-level access privileges shall be provided. A minimum of four (4) levels of access shall be supported.
- B. The highest level of access, Administrator Level access, shall allow the BAS administrator to perform application, database, and user management functions.
- C. Each login credentials shall be assigned to a pre-defined level of access. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user according to the level of access granted.
- D. Operators shall be able to perform only those commands available for the access level assigned to their login credentials.
- E. Login credentials are stored in the BC's local database. A minimum of 20 user names shall be supported and programmed per the DSU's direction.
- F. Login credentials can be looked up using the Lightweight Directory Access (LDAP) through the BAS server.
- G. Strong password shall be used on all login credentials.
- H. User-definable, automatic log-off timers from 1 to 60 minutes shall be provided to prevent users from inadvertently leaving interface device unattended.
- I. At system handover, all default and Contractor created login credentials for the system shall be provided to DSU and all temporary login credentials shall be removed.

#### **2.06 ALARM AND EVENT MANAGEMENT REPORTING**

- A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize

network traffic, and prevent alarms from being lost. At no time shall a BCs ability to report alarms be affected by either operator activity at an OWS or local handheld device, or by communications with other panels on the network.

1. Alarm Descriptor: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
  2. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of five (5) priority levels shall be provided - Level 1 Life Safety (i.e. smoke detector), Level 2 Critical (i.e. controller failure), Level 3 Abnormal (i.e. out-of-range temperature), Level 4 Energy Waste (i.e. fighting valves), Level 5 Maintenance Message (i.e. runtime monitor, filter status). For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with DSU on establishing alarm priority definitions.
  3. Alarm Report Routing: Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list and/or email to designated State email address (mailbox resource) associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
  4. Auto-Dial Alarm Routing: For alarm priority levels that include a mobile device as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate mobile device. System shall also be able to dial multiple mobile devices upon alarm activation.
  5. Alarm Acknowledgment: For alarm priority levels that are directed to a OWS, an indication of alarm receipt shall be displayed immediately regardless of the application is in use at the OWS, and shall remain on the screen until acknowledged by a user having a privilege that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the BC or CSS.
- B. It shall be possible for any operator to receive a summary of all alarms regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular BACnet event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.
- C. BACnet Alarming Services: All alarms and events shall be implemented using standard BACnet event detection and notification mechanisms. The workstation shall receive BACnet alarm and event notifications from any gateway or BACnet controller in the system and display them to an operator. Either intrinsic reporting or algorithmic change reporting may be used but the intrinsic reporting method is preferred. The workstation shall also log alarms and events, provide a way for an operator with sufficient privilege to acknowledge alarms, and log acknowledgements of alarms. It shall be possible for an operator to receive, at any time, a summary of all alarms that are currently in effect at any site whether or not they have been acknowledged. Operators shall also be able to view and change alarm limits for any alarm at the appropriate access level.
- D. Alarm Historical Database: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows data access services.

## 2.07 TRENDING

- A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
  - 1. Provide trends for all physical points, virtual points and calculated variables.
  - 2. BACnet Trend Objects are preferred but where not possible trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
  - 3. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
  - 4. The sample rate and data selection shall be selectable by the operator.
  - 5. The trended value range shall be selectable by the operator.
  - 6. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.
- B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.
- C. Data Buffering and Archiving: Trend data shall be buffered at the BC, and uploaded to hard disk storage when archival is desired. All archived trends shall be transmitted to the CSS. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.
- D. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

## 2.08 DYNAMIC PLOTTING

- A. Provide a utility to dynamically plot in real-time at least four (4) values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least five (5) dynamic plots shall be allowed simultaneously.

## 2.09 DATA ACQUISITION AND STORAGE

- A. All points included in the typical equipment point list must be represented in a common, open or accessible format. All points should be provided as BACnet standard analog, binary, schedule, or trend objects when possible. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.
- B. Non-BACnet data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.
- C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.
- D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows data access services.

## 2.10 TOTALIZATION

- A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents.

These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

- B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.
- C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

## 2.11 EQUIPMENT SCHEDULING

- A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.
- B. All schedules shall be implemented using BACnet objects and messages. All building systems with date and time scheduling requirements shall have schedules represented by the BACnet Schedule object. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any BACnet workstation.
- C. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.
- D. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.
- E. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A privilege level that does not allow assignment of master schedules shall allow a timed override feature.
- F. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

## 2.12 POINT STRUCTURING AND NAMING

- A. General: The intent of this section is to require a consistent means of naming points across all DSU facilities. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The convention is tailored towards the BACnet-based format and as such, the interface shall always use this naming convention. true BACnet systems shall also use this naming convention. For non-BACnet systems, the naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by DSU. The Contractor shall contact DSU to determine the Building number and abbreviation.
- B. Point Summary Table
  - 1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values in accordance with ASHARE 135 standard.
  - 2. With each schematic, Contractor shall provide a Point Summary Table listing:
    - a. Building number and abbreviation
    - b. System type
    - c. Equipment type
    - d. Point suffix
    - e. Full point name (see Point Naming Convention paragraph)
    - f. Point description
    - g. Ethernet backbone network number
    - h. Network number
    - i. Device ID
    - j. Device MAC address

- k. Object ID (object type, instance number)
- l. Engineering units.
- 3. Additional fields for non-BACnet systems shall be appended to each row. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).
- 4. Point Summary Table shall also illustrate Network Variables/BACnet Data Links Bindings.
- 5. The Contractor shall coordinate with DSU's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
- 6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to DSU the final Point Summary Table prior to Substantial Completion of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
- 7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.  
 Point Summary Table Example  
 Row Headers and Examples  
 (Transpose for a single point per row format)

Campus	RK
Building Number	006
Building Association	ZZ = no association (default to ZZ)
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
*Point Name (Object Name)	CA0006ZZ.COOLING.CHILLER.CHLR1KW
*Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Object Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
Included with Functional	

\*Represents information that shall reside in the relevant BACnet property for the object

C. Point Naming Convention

- 1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS object, a specific and unique BACnet object name shall be required.

2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. Use alphanumeric characters. Space and special characters are not allowed. Each of the four descriptors must be bound by a period to form the entire object name. Reference the paragraphs below for an example of these descriptors.
3. DSU shall designate the Building descriptor. The System descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The Equipment descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The Point descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the BAS network. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.  
 BACnet Object Name Requirements

Descriptors		Comment
Campus, Building Number & Building Association	RK0006ZZ AZ0134ZZ	The Master Building List also has the correct abbreviations for each building.
System	AIRHANDLING - EXHAUST - HEATING - COOLING - UTILITY - ENDUSE - MISC	Boilers and ancillary equipment Chillers and ancillary equipment Main electrical and gas meters Specific building loads by type
Equipment	BOILERS - CHILLERS - FACILITY - TOWERS - WEATHER	Non-specific boiler system points - Non-specific chiller system points
Point Suffix	See Input/Output point summary table for conventions	

5. Examples: Within each object name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:
    - a. RK0006ZZ.COOLING.CHILLERS.CHWP1ST
    - b. RK0006ZZ.HEATING.BOILERS.BLR1CFH
- D. Device Addressing Convention:
1. BACnet network numbers and Device Object IDs shall be unique throughout the network.
  2. All assignment of network numbers and Device Object IDs shall be coordinated with DSU.
  3. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:
    - a. BBBFF, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.
  4. Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:
    - a. XXFFBBB, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.
  5. The BAS Contractor shall coordinate with designated State representative to ensure that no duplicate Device Object IDs occur.

6. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by DSU.

### **2.13 OPERATOR INTERFACE GRAPHIC SOFTWARE**

- A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.
- B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a web-based environment. All functions excepting text entry functions shall be executable with a mouse.
- C. Graphic software shall display current operating mode (i.e. warm-up, dehumidification, et al) for equipment with multiple modes of operation.
- D. Graphic software shall provide for multitasking such that other application can be used while the operator is accessing the BAS. Software shall provide the ability to alarm graphically even when operator is in another software package.
- E. The software shall be compatible to the current and current minus one versions of Microsoft Windows operating system. The software shall allow for the DSU's creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of a pointing device; e.g. mouse and touch screen.
- F. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the pointing device to select from menus or 'button' icons. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.
- G. Dynamic Data Displays: Dynamic physical point values shall automatically updated at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.
- H. Point Override Feature: Each displayed point shall be individually enabled/disabled to allow pointing device driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the BAS software. The graphic point override feature shall be subject to privilege level protection. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's login name. A list of points that are currently in an override state shall be available through menu selection and include the time/date of the override along with the operator's login name that initiated that override.
- I. Dynamic Symbols: Provide a selection of standard symbols that change in appearance based on the value of an associated point.
  1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.
  2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.
  3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.
- J. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
  1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.

2. The Graphic Development Package shall use a pointing device to allow the user to perform the following:
  - a. Define symbols
  - b. Position items on graphic screens
  - c. Attach physical or virtual points to a graphic
  - d. Define background screens
  - e. Define connecting lines and curves
  - f. Locate, orient and size descriptive text
  - g. Define and display colors for all elements
  - h. Establish correlation between symbols or text and associated system points or other displays
  - i. Create hot spots or link triggers to other graphic displays or other functions in the software
- K. Graphic images shall reside on the CSS.
- L. The software shall be capable of initiating communication between the BC and the CSS:
  1. Upon user command, to perform all specified functions.
  2. In accordance with user-programmed time schedules to report alarms and upload trend and report data to the CSS.
- M. The software shall automatically terminate the communication when all specified functions are completed.

### **PART 3 - EXECUTION**

#### **3.01 SYSTEM CONFIGURATION**

- A. Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, BC and CSS, if necessary .

#### **3.02 SITE-SPECIFIC APPLICATION PROGRAMMING**

- A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequences of operation. It is the Contractor's responsibility to request clarification on sequence issues that require such clarification.
- B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.
- C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of DSU and shall remain on the BC and CSS at the completion of the project.

#### **3.03 PRIVILEGE LEVELS SETUP**

- A. Set up the following privilege levels to include the specified capabilities:
  1. Level 1: (DSU's BAS Administrator)
    - a. Level 2 capabilities
    - b. Configure system software
    - c. Modify graphic software
    - d. View, add, change and delete user login credentials and privilege levels
    - e. All unrestricted system capabilities including all network management functions.
  2. Level 1a (Contractor Technician)
    - a. Level 2 capabilities
    - b. Configure system software
    - c. Modify graphic software
  3. Level 2: (Maintenance Manager)
    - a. Level 3 capabilities

- b. Modify control unit programs
  4. Level 3: (Senior BAS Technician)
    - a. Level 4 capabilities
    - b. Override output points
    - c. Change setpoints
    - d. Change equipment schedules
  5. Level 4: (Junior BAS Technician and Trainee)
    - a. Level 5 capabilities
    - b. Acknowledge alarms
    - c. Temporarily override equipment schedules
  6. Level 5: (Read Only)
    - a. Display all graphic data
    - b. Trend point data
- B. Contractor shall assist:
  1. DSU's BAS Administrator with assigning user login credentials and privilege levels, configure system software and modify graphic software.
  2. Maintenance Manger with modifying control unit programs.

### 3.04 POINT PARAMETERS

- A. Provide the following minimum programming for each analog input:
  1. Name
  2. Address
  3. Scanning frequency or COV threshold
  4. Engineering units
  5. Offset calibration and scaling factor for engineering units
  6. High and low alarm values and alarm differentials for return to normal condition
  7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
  8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
  9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.
- B. Provide the following minimum programming for each analog output:
  1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units
  5. Offset calibration and scaling factor for engineering units
  6. Output Range
  7. Default value to be used when the normal controlling value is not reporting.
- C. Provide the following minimum programming for each digital input:
  1. Name
  2. Address
  3. Engineering units (on/off, open/closed, freeze/normal, etc.)
  4. Debounce time delay
  5. Message and alarm reporting as specified
  6. Reporting of each change of state, and memory storage of the time of the last change of state
  7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

- D. Provide the following minimum programming for each digital output:
1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units (on/off, open/closed, freeze/normal, etc.)
  5. Direct or Reverse action selection
  6. Minimum on-time
  7. Minimum off-time
  8. Status association with a DI and failure alarming (as applicable)
  9. Reporting of each change of state, and memory storage of the time of the last change of state.
  10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
  11. Default value to be used when the normal controlling value is not reporting.

### 3.05 TRENDS

- A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point, and all dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like as directed by DSU.
- B. DSU will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.
1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.
- C. Sample times indicated as COV ( $\pm$ ) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.
- D. Trending intervals or COV thresholds shall be dictated by DSU upon system start-up.
- E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before Substantial Completion of the system.

### 3.06 TREND GRAPHS

- A. Prepare controller and graphic software to display graphical format trends. Trended values and intervals shall be the same as those specified.
- B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
- C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.
- D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
- E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
- F. All points trended for one subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.
- G. Each graph shall be clearly labeled with the subsystem title, date, and times.

### 3.07 ALARMS

- A. Override Alarms: Any point that is overridden through the override feature of the graphic software shall be reported as a Level 3 alarm.
- B. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:
  - 1. Space temperature, except as otherwise stated in sequence of operation: Level 3
    - a. Low alarm: 64°F
    - b. Low return-to-normal: 68°F
    - c. High alarm: 85°F
    - d. High return-to-normal: 80°F
  - 2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)
    - a. Low alarm: 3°F below setpoint
    - b. Low return-to-normal: 2°F below setpoint
    - c. High alarm: 3°F above setpoint
    - d. High return-to-normal: 2°F above setpoint.
  - 3. AHU mixed air temperature: Level 4
    - a. Low alarm: 45°F
    - b. Low return-to-normal: 46°F
    - c. High alarm: 90°F
    - d. High return-to-normal: 89°F
  - 4. Duct Pressure:
    - a. Low alarm: 0.5" w.g. below setpoint
    - b. Low return-to-normal: 0.25" w.g. below setpoint
    - c. High alarm: 0.5" w.g. above setpoint
    - d. High return-to-normal: 0.25" w.g. above setpoint
  - 5. Space humidity:
    - a. Low alarm: 35%
    - b. Low return-to-normal: 40%
    - c. High alarm: 75%
    - d. High return-to-normal: 70%
- C. HOA Switch Tampering Alarms: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the 'Auto' position. [If a motorized equipment unit starts without a prior start command from the FMS, (as sensed by status sensing device), then FMS shall perform the remaining sequence as specified.] BAS shall also enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present:
  - 1. DEVICE XXXX FAILURE: Status is indicated on the device even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.
- D. Maintenance Alarms: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator
  - 1. DEVICE XXXX REQUIRES MAINTENANCE. Runtime has exceeded specified value since last reset.
- E. See requirements for additional equipment-specific alarms specified in Section 23 09 59 - Sequences of Operation.

### 3.08 GRAPHIC SCREENS

- A. Floor Plan Screens: The contract document drawings will be made available to the Contractor in AutoCAD (current version) format upon request. These drawings may be used only for developing backgrounds for specified graphic screens; however DSU does not guarantee the suitability of these drawings for the Contractor's purpose.
1. Provide graphic floor plan screens for each floor of the building. Indicate the location of all equipment that is not located on the equipment room screens. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens. [Zone background color shall change based on the temperature offset from setpoint]. Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone. [Mechanical floor plan drawings will be made available to the contractor upon request for the purpose of determining zone boundaries.] Indicate room numbers as provided by DSU. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.
  2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
  3. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
  4. Provide a graphic site plan with links to and from each building plan.
- B. System Schematic Screens: Provide graphic system schematic screen for each subsystem controlled with each I/O point in the project appearing on at least one graphic screen. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a hover box when the operator moves the cursor over the displayed point. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.
1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
  2. Provide a graphic screen for each zone. Provide links to graphic system schematic screens of air handling units that serve the corresponding zone.
  3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link screens for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic screen.
  4. Link screens for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
- C. Bar Chart Screens: On each graphic Bar Chart Screen, provide drawing links to the graphic air handling unit schematic screens.
1. Provide a graphic chilled water valve screen showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open

- valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
2. Provide a graphic heating water valve screen showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.
- D. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color.

**END OF SECTION**

**SECTION 23 09 58**  
**SEQUENCE OF OPERATION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Central Plants

**1.02 RELATED DOCUMENTS:**

- A. Section 23 09 50 - Building Automation System (BAS) General
- B. Section 23 09 51 - BAS Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 54 - BAS Communications Devices
- E. Section 23 09 55 - BAS Software
- F. Section 23 09 59 - BAS Commissioning

**1.03 SYSTEM DESCRIPTION**

- A. The systems to be controlled under work of this section basically comprise (describe the scope of the project). The systems being controlled are (describe the configuration of and the type of systems included in the project).
- B. This Section defines the manner and method by which controls function.

**1.04 SUBMITTALS**

- A. Refer to Section 23 09 50 and Division 1 for requirements for control shop drawings, product data, User Manual, etc.
- B. Programming Manual: Provide BAS system programming manual as well as documentation of site-specific programming prior to the start of Acceptance Phase.

**1.05 PROJECT RECORD DOCUMENTS**

- A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual setpoints and tuning parameters as existed at acceptance.
- B. Record documents shall be modified control drawings with the actual installed information. Drawings shall be delivered in both reproducible hard copy and electronic format in AutoCAD (current version) drawing files. Provide all supporting files, blocks, fonts, etc. required by the drawings.
- C. Provide final points list as described above.
- D. Provide final detailed wiring diagrams with all wire numbers and termination points indicated.
- E. Accurately record final sequences and control logic made after submission of shop drawings.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.
- B. When an air handling unit is not in operation, control devices shall remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices shall be as follows:

Device	"Off Position"	"Normal Position"
--------	----------------	-------------------

Heating coil valves	closed	open
Outside air damper	closed	closed
Exhaust/relief air damper	closed	closed
Var. Freq. Drive	off	Min. speed

- C. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.
- D. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used (Designer coordinate with DSU regarding actual occupancy schedules and initial setpoints):
  1. Occupied Period: Period of time when the building is in use and occupied. Unless indicated otherwise, this period is defined as X:XX AM - X:XX PM weekdays and X:XX AM to 12:00PM (noon) Saturdays. Exclude all national holidays. Generally systems will be fully operational throughout this period and ventilation air shall be continuously introduced. Space temperature setpoints will generally be in the “normal” range of 69-77°F.
  2. Unoccupied period: Period of time when the building or zone is not in use and unoccupied. Ventilation air shall not be introduced.
  3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to “normal” or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling. Time period shall be determined by an optimum start strategy unless otherwise specified.
  4. Setback Period: Setback will typically coincide start with the end of the occupied period and end with the start of the preoccupancy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a “setback” temperature.
- E. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.
- F. Alarm messages specified throughout the sequences are assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports, and are defined in Section 23 09 55 - ATC System Software and Programming.
- G. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper privilege level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.
- H. When a power failure is detected in any phase, the BAS start commands shall be retracted immediately from all electrically powered units served by the failed power source. If the associated primary control unit (PCU) is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the PCU is powered by uninterruptable power supply (UPS), or if PCU is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that power has been restored, all equipment for which the BAS start command had been retracted shall be automatically restarted on staggered 5 second intervals to minimize inrush current. When loss of equipment status coincides with a power failure, system shall not alarm individual equipment failures. Instead, only a single Level 2 alarm shall be enunciated as follows:

1. BUILDING XXXX POWER FAILURE: Notify electric shop. Acknowledge alarm when power is restored.
- I. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:
  1. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
  2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
  3. Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.
- J. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:
  1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. space temperature) setpoint. The reset increment shall be determined by the quantity of "need heat" or "need cool" requests from individual SCU's. A SCU's "need heat" virtual point shall activate whenever the zone's space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A SCU's "need cool" virtual point shall activate whenever the zone's space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.
- K. Where "prove operation" of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS shall, after an adjustable time delay after the device is commanded to operate (feedback delay) , confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm shall be enunciated audibly and via an alarm message at the operator interface and print at the alarm printers. A descriptive message shall be attached to the alarm message indicating the nature of the alarm and actions to be taken. Contractor shall provide messages to meet this intent. [Upon failure of equipment with redundant backup, run command shall be removed from equipment and the device shall be locked out until the alarm is manually acknowledged. Upon failure of equipment without redundant backup, run command shall remain energized and the alarm shall be latched until reset by an operator. BAS shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
  1. Speed control of variable speed drives
  2. Chiller supply water temperature setpoint reset
  3. Chiller demand limit
  4. Travel rate of tower isolation and chiller isolation valves
- L. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.
- M. The following chilled water sequence applies to the classic primary/secondary chilled water system where the bypass is positioned for equal percent unloading of all chillers, constant

speed primary pumps one per chiller, multiple secondary chilled water pumps controlled from a variable speed drive. Various staging scenarios are included and the designer should select the most optimal method for the applicable job.

### **3.02 CENTRAL PLANT EQUIPMENT - MONITORING AND MANAGEMENT**

- A. General: The BAS shall monitor various aspects of the heating and cooling systems and calculate parameters as specified below to facilitate plant operations and management.
- B. Trending: The BAS shall continuously monitor, calculate and display the following parameters at the intervals indicated. These values shall be stored and reported per the trending requirements defined in Section 23 09 55.
- C. Parameters to be trended:
  - 1. Load on the secondary systems in MBH per the following equation:  $(\text{Return Temp} - \text{Supply Temp}) * (\text{GPM}) / .5$ . This shows cooling as a positive heat load and heating as a negative heat load. Note that multipliers on this value to accommodate the BAS processors are acceptable as long as they are clearly indicated. This value shall be trended and stored every two hours.
  - 2. All temperature sensors at 1 hour intervals
  - 3. All relative humidity sensors at 1 hour intervals
  - 4. All pressure sensors at 1 hour intervals
  - 5. All run requests and statuses on a change in value
  - 6. All analog loop outputs on 1 hour intervals
  - 7. Calculated enthalpies in 2 hour intervals
  - 8. Summed cooling and heating requests on 2 hour intervals

**END OF SECTION**

**SECTION 23 09 59**  
**BAS SYSTEM COMMISSIONING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. BAS and equipment testing and start-up
- B. Validation of proper and thorough installation of BAS and equipment
- C. Functional testing of control systems
- D. Documentation of tests, procedures, and installations
- E. Coordination of BAS training
- F. Documentation of BAS Operation and Maintenance materials

**1.02 RELATED SECTIONS:**

- A. Section 23 09 50 - BAS General Requirements
- B. Section 23 09 51 - BAS Basic Materials and Devices
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 54 - BAS Communication Devices
- E. Section 23 09 55 - BAS Software and Programming
- F. Section 23 09 58 - Sequence of Operation

**1.03 GENERAL DESCRIPTION**

- A. This section defines responsibilities of the Controls Contractor to commission the BAS.
- B. Delaware State University, at Delaware State University's expense, shall retain a Commissioning Authority (CA) who shall work with the Contractor to ensure that the systems, equipment, and interfaces are installed, tested, and operate per the design intent; that the systems are adequately documented; and that DSU is adequately trained on system intent, operation, and maintenance.

The following is written based on the use of a separate Commissioning Authority (CA). If that is not the case on the project, the Contractor must still start up and commission the BAS. Therefore edit the responsibilities as appropriate for the project commissioning requirements.

**1.04 CONTRACTOR RESPONSIBILITIES**

- A. Completely install and thoroughly inspect, startup, test, adjust, balance, and document all systems and equipment.
- B. Assist Commissioning Authority in performing verification and performance testing. This will generally include the following:
  - 1. Attend Commissioning (Cx) progress and coordination meetings.
  - 2. Prepare and submit required draft forms and systems information.
  - 3. Establish trend logs of system operation as specified herein.
  - 4. Demonstrate system operation.
  - 5. Manipulate systems and equipment to facilitate testing.
  - 6. Provide instrumentation necessary for verification and performance testing.
  - 7. Manipulate control systems to facilitate verification and performance testing.
  - 8. Train DSU's Representatives as specified in Part III of this section.
- C. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of [80] hours. Refer to Part 3 for a description of the software optimization.

**1.05 SEQUENCING**

- A. The following list outlines the general sequence of events for submittals and commissioning:
  - 1. Submit product data and shop drawings, and receive approval.

2. Submit BAS logic documentation, and receive approval.
3. Submit Start-Up Checklists and manufacturer's start-up procedures for all equipment provided by the BAS Contractor.
4. Install BAS.
5. Submit BAS Start-Up Test Agenda and Schedule for review.
6. Receive BAS start up Test Agenda/schedule approval.
7. Submit Training Plan.
8. Simulate sequencing and debug program off-line to the extent practical.
9. Place systems under BAS control where applicable during a scheduled outage.
10. Perform BAS start up where applicable during a scheduled outage.
11. Prepare and initiate trend log data storage and format trend graphs.
12. Submit completed BAS Start-Up Reports and initial draft of the O&M Manuals.
13. Receive BAS Start Up Report approval and approval to schedule Demonstrations and Commissioning.
14. Demonstrate systems to Commissioning Authority and DSU.
15. Submit Trend Logs in format specified.
16. Receive demonstration approval and approval to schedule Acceptance Period.
17. Train DSU on BAS operation and maintenance.
18. Substantial Completion.
19. Begin Acceptance Phase.
20. Two week Operational Test.
21. Perform Functional Performance Testing.
22. Receive Acceptance Period approval, which is Functional Completion for the BAS.
23. Train DSU on final sequences and modes of operation.
24. Install framed control drawings. (See Section 23 09 50/1.09/G)
25. Provide Level 1 password access to DSU.
26. Revise and re-submit record drawings and O&M Manuals.
27. Substantial Completion.
28. Begin Warranty Phase.
29. Schedule and begin Opposite Season acceptance period.
30. Receive Opposite Season acceptance period approval.
31. Submit as-built drawings and O&M Manuals.
32. Update framed control drawings. (See Section 23 09 50/1.09/G)
33. Complete State personnel Training.
34. End-of-Warranty date/period.

## **PART 2 - PRODUCTS**

### **2.01 INSTRUMENTATION**

- A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by Contractor and made available to Commissioning Authority. Generally, no testing equipment will be required beyond that required to perform Contractors work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

### **2.02 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL**

- A. For new projects, Contractor shall provide a portable operators terminal or hand held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up.
- B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box. Otherwise a wireless system shall be provided to facilitate this local functionality.

### **PART 3 - EXECUTION**

#### **3.01 BAS START-UP TESTING, ADJUSTING, CALIBRATION**

- A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:
1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
  2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
  3. Verify integrity/safety of all electrical connections.
  4. For the following control settings, initially use the control setting that was used by existing control system, unless otherwise indicated. For AHUs that use a throttled outside air damper position when minimum outside air is required, contractor shall mark existing minimum outside air damper position to allow replication by new controls.
  5. Coordinate with TAB subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:
    - a. Optimum duct static pressure setpoints for VAV air handling units.
    - b. Minimum outside air damper settings for air handling units.
    - c. Optimum differential pressure setpoints for variable speed pumping systems.
    - d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
      - 1) BAS contractor shall provide hand-held device as a minimum to the TAB and CA to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
  6. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start Up Report.
  7. Check and set zero and span adjustments for all transducers and transmitters.
  8. For dampers and valves:
    - a. Check for adequate installation including free travel throughout range and adequate seal.
    - b. Where loops are sequenced, check for proper control without overlap.
  9. For actuators:
    - a. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
    - b. Check for appropriate fail position, and that the stroke and range is as required.
    - c. For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.
    - d. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
  10. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.

11. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
12. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
13. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
14. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):
  - a. Duct air temperature:  $\pm 1^{\circ}\text{F}$ .
  - b. Space Temperature:  $\pm 2^{\circ}\text{F}$
  - c. Chilled Water:  $\pm 1^{\circ}\text{F}$
  - d. Hot water temperature:  $\pm 3^{\circ}\text{F}$ .
  - e. Condenser water temperature:  $\pm 3^{\circ}\text{F}$ .
  - f. Duct pressure:  $\pm 0.25''$  w.g.
  - g. Water pressure:  $\pm 1$  psid
  - h. Duct or space Humidity:  $\pm 5\%$
  - i. Air flow control:  $\pm 5\%$  of setpoint velocity. [For fume hoods  $\pm 10\%$  on full sash travel (from min to max in 3 seconds) within 3 seconds. Refer to Section 15995 for fume hood acceptance requirements.] [For minimum OA flow loops being reset from CO<sub>2</sub>, response to upset max time is one hour.]
  - j. Space Pressurization (on active control systems):  $\pm 0.05''$  wg with no door or window movements.
15. For interface and DDC control panels:
  - a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
  - b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
  - c. Check power supplies for proper voltage ranges and loading.
  - d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
  - e. Check for adequate signal strength on communication networks.
  - f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
  - g. Ensure that all outputs and devices fail to their proper positions/states.
  - h. Ensure that buffered and/or volatile information is held through power outage.
  - i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
  - j. Check for adequate grounding of all DDC panels and devices.
16. For Operator Interfaces:
  - a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
  - b. Output all specified BAS reports for review and approval.
  - c. Verify that the alarm printing and logging is functional and per requirements.
  - d. Verify that trends are archiving to disk and provide a sample to the [Commissioning Authority and] State for review.
  - e. Verify that paging/dial-out alarm annunciation is functional.
  - f. Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.

- g. Verify that required third party software applications required with the bid are installed and are functional.
  - 17. Start-up and check out control air compressors, air drying, and filtering systems in accordance with the appropriate section and with manufacturer's instructions.
  - 18. Verify proper interface with fire alarm system.
- B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Substantial Completion.

### 3.02 SENSOR CHECKOUT AND CALIBRATION

- A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.
- B. Calibration: Calibrate all sensors using one of the following procedures:
- 1. Sensors Without Transmitters - Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
  - 2. Sensors With Transmitters - Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
- C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Section 23 09 51.

### 3.03 COIL VALVE LEAK CHECK

- A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

### 3.04 VALVE STROKE SETUP AND CHECK

- A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

### 3.05 BAS DEMONSTRATION

- A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and DSU. Schedule the demonstration with the DSU's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration, Contractor shall reimburse DSU for costs of subsequent Commissioning Authority site visits.
- B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
- C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by DSU.
- D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:
  - 1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
  - 2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
  - 3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
  - 4. Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Commissioning Authority and/or State for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
  - 5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
  - 6. Demonstrate that all DDC programs accomplish the specified sequences of operation.
  - 7. Demonstrate that the panels automatically recover from power failures, as specified.
  - 8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
  - 9. Identify access to equipment selected by Commissioning Authority. Demonstrate that access is sufficient to perform required maintenance.
  - 10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- E. BAS Demonstration shall be completed and approved prior to Substantial Completion.
- F. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

### 3.06 BAS ACCEPTANCE PERIOD

- A. After approval of the BAS Demonstration and prior to Contract Close Out Acceptance Phase shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, and the like), and TAB report has been submitted and approved. Acceptance Period and its approval will be performed on a system-by-system basis if mutually agreed upon by the Contractor and DSU0.

- B. Operational Test: At the beginning of the Acceptance Phase, the system shall operate properly for two weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, contractor shall forward the trend logs to the Commissioning Authority for review. Commissioning Authority shall determine if the system is ready for functional performance testing and document any problems requiring contractor attention.
  - 1. If the systems are not ready for functional performance testing, Contractor shall correct problems and provide notification to the DSU's representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one-week period. This process shall be repeated until Commissioning Authority issues notice that the BAS is ready for functional performance testing.
- C. During the Acceptance Period, the contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify DSU's representative.

### **3.07 TREND LOGS**

- A. Contractor shall configure and analyze all trends required under Section 23 09 55.

### **3.08 TREND GRAPHS**

- A. Trend graphs as specified in Section 23 09 55 shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.
- B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

### **3.09 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING:**

- A. Trending: throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the Commissioning Authority/ DSU for review upon Commissioning Authority/ DSU's request. Commissioning Authority/ DSU will review these and notify contractor of any warranty work required.
- B. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, Commissioning Authority/DSU shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

### **3.10 SOFTWARE OPTIMIZATION ASSISTANCE**

- A. The Contractor shall provide the services of a BAS Technician as specified above at the project site to be at the disposal of the Commissioning Authority. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the Commissioning Authority during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, Commissioning Authority, and DSU. DSU's representative shall notify contractor 2 days in advance of each day of requested assistance.
- B. The BAS Technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS Technician provided cannot perform every software task requested by the Commissioning Authority in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority, to meet the total specified requirement on-site.

### 3.11 BAS OPERATOR TRAINING AND O&M MANUALS

- A. Provide up to 4 complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.
- B. Contractor shall submit a Training Plan for the scope of training for which they are responsible. Training Plan shall be forwarded to the Division 23 Contractor who will compile, organize, format, and forward to the Engineer for review.
- C. On-Site Training: Provide services of controls contractor's qualified technical personnel for [five] 8-hour days to instruct DSU's personnel in operation and maintenance of BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of DSU. The DSU's representative shall notify contractor 1 week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the Engineer and DSU's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:
  1. Basic Operator Workstation (OWS) Training - For all potential users of the OWS:
    - a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
    - b. Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
    - c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
    - d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
    - e. Overview of systems installed.
    - f. Present all site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.
    - g. Overview of alarm features.
    - h. Overview of trend features.
    - i. Overview of workstation reports.
  2. BAS Hardware Training - For Maintenance and Control Technicians
    - a. Review of installed components and how to install/replace, maintain, commission, and diagnose them
  3. BAS Technician Training
    - a. Introduction to controller programming and overview of the programming application interface.
    - b. General review of sequence of operation and control logic for the project site, including standalone and fail-safe modes of operation.
    - c. Uploading/Downloading and backing up programs.
    - d. Network administration.
    - e. Review of setpoint optimization and fine-tuning concepts.
  4. Advanced Training: Advanced Training shall be provided for one (1) individual and be provided at an off-site training facility containing installations of the proposed system. Contractor shall pay training registration and materials fee and DSU shall pay all employee expenses (travel, per diem, salary).
    - a. Contractor shall provide the standard, advanced training offering on all Control Programming Applications.
    - b. Contractor shall provide the standard, advanced training offering on Advanced Installation, Configuration, Maintenance, and Network Administration.
    - c. For Echelon-based systems, advanced training shall include a Lon systems integration course.

**END OF SECTION**



**SECTION 23 09 69**  
**VARIABLE FREQUENCY CONTROLLERS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase motors.

**1.03 DEFINITIONS**

- A. BMS: Building management system.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFC: Variable frequency controller.

**1.04 SUBMITTALS**

- A. Product Data: For each type of VFC, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings (for each VFC):
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current ratings of integrated unit.
    - d. UL listing for series rating of overcurrent protective devices in combination controllers.
  - 2. Wiring Diagrams: Power, signal, and control wiring for VFC. Provide schematic wiring diagram for each type of VFC.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For testing agency and manufacturer.
- E. Field Test Reports: Written reports specified in Part 3.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for VFCs and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

### **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

### **1.07 COORDINATION**

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- C. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

### **1.08 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
  - 1. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating
  - 2. Indicating Lights: Two of each type installed.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
  - 2. Yaskawa, Inc.
  - 3. Danfoss

### **2.02 VARIABLE FREQUENCY CONTROLLERS**

- A. Unit and options shall be UL508 Listed as a complete assembly.
- B. Unit shall be listed for minimum 100 KA SCCR without the need for external input fuses.
- C. Microprocessor based Bypass Controller - Manual or automatic (selectable) transfer to line power via contactors. A keypad to control the bypass controller is to be mounted on the enclosure door. The bypass keypad shall include a one line diagram and status LEDs to indicate the mode of operation and "External Fault" conditions. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position, both contactors are open, in the "Bypass" position, the drive output contactor is open, and the

bypass contactor is closed. Start/stop via customer supplied maintained contact shall be 24V or 115V compatible and shall function in both the "Normal" and "Bypass" modes. The voltage tolerance of the bypass power supply shall be  $\pm 35\%$  to eliminate the problem of contactor coil burnout. The design shall include single-phase protection in both the AFD and bypass modes.

- D. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. Include fireman's override and damper control circuit as standard. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes.
- E. Automatic bypass operation shall be selectable in the standard microprocessor based bypass design.
- F. Door / cover interlocked circuit breaker disconnect switch which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be through the door, and be padlockable in the "Off" position.
- G. Fast acting semi-conductor fuses exclusive to the AFD – fast acting semi-conductor fuses allow the AFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs which have no such fuses, or that incorporate fuses common to both the AFD and the bypass will not be accepted. In such designs, a fuse clearing failure would render the bypass unusable.
- H. Class 10 or 20 (selectable) electronic motor overload protection shall be included in the microprocessor bypass to protect the motor in bypass mode.
- I. 3% DC line reactor
- J. Input AC Line Reactor
- K. The following operating information displays shall be standard on the AFD digital display. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of two operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
  - 1. Output Frequency
  - 2. Motor Speed (RPM, %, or Engineering units)
  - 3. Motor Current
  - 4. Calculated Motor Torque
  - 5. Calculated Motor Power (kW)
  - 6. DC Bus Voltage
  - 7. Output Voltage
  - 8. Heatsink Temperature (OF)
  - 9. Analog Input Values
  - 10. Analog Output Value
  - 11. Keypad Reference Values
  - 12. Elapsed Time Meter (resettable)
  - 13. kWh meter (resettable)
  - 14. mWh meter
  - 15. Digital input status
  - 16. Digital output status
- L. Communications: Provide an ethernet interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via a BACNet IP BMS. Provide capability for VFC to retain these settings within the nonvolatile memory.

### 2.03 ENCLOSURES

- A. Enclosure: NEMA 250 Type I, with hinged full front access.

## **2.04 FACTORY FINISHES**

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 INSTALLATION**

- A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with VFC mounting surface.
- B. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

### **3.03 IDENTIFICATION**

- A. Identify VFCs, components, and control wiring according to Division 15 Section "Mechanical identification."
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFCs.
- B. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

### **3.05 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.

### **3.06 CLEANING**

- A. Clean VFCs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

### **3.07 DEMONSTRATION**

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

**END OF SECTION**

**SECTION 23 21 13**  
**HYDRONIC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Pipe and pipe fittings for:
  - 1. Heating water piping system.
  - 2. Equipment drains and overflows.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:
  - 1. Gate valves.
  - 2. Globe or angle valves.
  - 3. Ball valves.
  - 4. Manual Calibrated Balancing Valves
  - 5. Butterfly valves.
  - 6. Check valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 07 19 - HVAC Piping Insulation.
- D. Section 23 21 14 - Hydronic Specialties.
- E. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

**1.03 REFERENCE STANDARDS**

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; The American Society of Mechanical Engineers; 2013.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; 2013.
- D. ASME B31.9 - Building Services Piping; 2014 (ANSI/ASME B31.9).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- F. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2013.
- I. ASTM B32 - Standard Specification for Solder Metal; 2008.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
- K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- L. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- M. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).

- N. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.
- O. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2010 w/Errata.
- Q. AWWA C606 - Grooved and Shouldered Joints; 2011 (ANSI/AWWA C606).
- R. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

#### **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications: Certify in accordance with ASME BPVC-IX.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### **1.07 FIELD CONDITIONS**

- A. Do not install underground piping when bedding is wet or frozen.

### **PART 2 PRODUCTS**

#### **2.01 HYDRONIC SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
  - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
  - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals. Provide shut off valve to allow for replacement of the fitting without draining the entire system. The shut off valve shall be constructed of the material matching the pipe it's on.
  - 3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
  - 4. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:

1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
3. For throttling, bypass, or manual flow control services, use globe valves.
4. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
5. In heating water or chilled water systems, butterfly valves may be used interchangeably with gate and globe valves.
6. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

## **2.02 HEATING WATER PIPING, ABOVE GRADE**

- A. The intent is to provide Copper Tube up to 2" and Steel piping for larger than 2". However we would like to minimize the change in materials therefore, should a condition be found that maintaining one piping material for a short length in a size not listed for that material would reduce the amount of dielectric fittings, this condition shall be presented to the engineer for review.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
  1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
  2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

## **2.03 EQUIPMENT DRAINS AND OVERFLOWS**

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

## **2.04 PIPE HANGERS AND SUPPORTS**

- A. Provide hangers and supports that comply with MSS SP-58.
  1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Conform to ASME B31.9.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
- D. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- F. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- H. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- I. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- J. Vertical Support: Steel riser clamp.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

- L. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

## **2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS**

- A. Unions for Pipe 2 Inches and Under:
- B. Flanges for Pipe Over 2 Inches:
  - 1. Gaskets: 1/16 inch thick preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
  - 1. Dimensions and Testing: In accordance with AWWA C606.
  - 2. Mechanical Couplings: Comply with ASTM F1476.
  - 3. Housing Material: Malleable iron or ductile iron, galvanized.
  - 4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
  - 5. When pipe is field grooved, provide coupling manufacturer's grooving tools.

## **2.06 GATE VALVES**

- A. Manufacturers:
  - 1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  - 2. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
  - 3. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  - 4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Up To and Including 2 Inches:
  - 1. Bronze body, bronze trim, union bonnet, rising stem, lockshield stem, inside screw with backseating stem, solid wedge disc, alloy seat rings, solder ends.
- C. Over 2 Inches:
  - 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

## **2.07 GLOBE OR ANGLE VALVES**

- A. Manufacturers:
  - 1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  - 2. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
  - 3. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  - 4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Up To and Including 2 Inches:
  - 1. Bronze body, bronze trim, union bonnet, rising stem and handwheel, inside screw with backseating stem, renewable plug disc and stainless steel seat ring, solder ends.
  - 2. Balancing ports and caps must be provided with globe or angle valves used for balancing.
- C. Over 2 Inches:
  - 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.
  - 2. Balancing ports and caps must be provided with globe or angle valves used for balancing.

## **2.08 BALL VALVES**

- A. Manufacturers:
  - 1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  - 2. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
  - 3. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  - 4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Up To and Including 2 Inches:

1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle extended shaft to allow handle to turn above insulation, solder ends with union.

## 2.09 MANUAL CALIBRATED BALANCING VALVES

- A. Valve Characteristics ½" to 2" "Y" Pattern Globe
  1. 300 psi/2065 kPa, y-pattern, globe type with soldered or threaded ends, non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter. Tour and Andersson TA Series 786-STAS or 787-STAD or equal by Armstrong or Wheatley.
- B. Valve Characteristics 2 ½ to 16" "Y" Pattern Globe
  1. 300 psi/2065 kPa, y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12, 16, 20 or 22 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter. Tour and Andersson TA Series 788-STAF or 789-STAG or equal by Armstrong or Wheatley.
- C. Balancing Meter
  1. A balancing meter is required to be left with the owner after commissioning, the balancing meter shall be from the same provider as the balancing valves, Victaulic. The Series 734 TA-Scope, or TA Series 73M CMI Pressure Differential Meter are acceptable and are manufactured by Tour and Andersson and provided by Victaulic. Needle gauge type meters will not be allowed.

## 2.10 BUTTERFLY VALVES

- A. Manufacturers:
  1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  2. Hammond Valve: [www.hammondvalve.com](http://www.hammondvalve.com).
  3. Crane Co.: [www.cranevalve.com](http://www.cranevalve.com).
  4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- E. Disc: Stainless steel.
- F. Operator: Infinite position lever handle with memory stop.

## 2.11 SPRING LOADED CHECK VALVES

- A. Manufacturers:
  1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  2. Hammond Valve: [www.hammondvalve.com](http://www.hammondvalve.com).
  3. Crane Co.: [www.cranevalve.com](http://www.cranevalve.com).
  4. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.

- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls and floors.
- F. Slope piping and arrange to drain at low points.
- G. Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
  - 2. Support horizontal piping as scheduled.
  - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  - 4. Place hangers within 12 inches of each horizontal elbow.
  - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- J. Install valves with stems upright or horizontal, not inverted.

### 3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
  - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  - 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
  - 1. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 2. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 3. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  - 4. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
  - 5. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  - 6. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
  - 7. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

**END OF SECTION**

**SECTION 23 21 14**  
**HYDRONIC SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Air vents.
- B. Air separators.
- C. Strainers.
- D. Suction diffusers.
- E. Pressure-temperature test plugs.
- F. Balancing valves.
- G. Combination flow controls.
- H. Flexible Pump Connectors
- I. Flow indicators, controls, meters.
- J. Relief valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

**1.03 REFERENCE STANDARDS**

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

**1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- E. Maintenance Materials: Furnish the following for Delaware State University's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Extra Glycol Solution: One container, 55 gallon size.

**1.06 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

## **PART 2 PRODUCTS**

### **2.01 AIR VENTS**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
  - 2. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
  - 3. Taco, Inc: [www.taco-hvac.com](http://www.taco-hvac.com).
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
  - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

### **2.02 AIR SEPARATORS**

- A. In-line Air Separators:
  - 1. Manufacturers:
    - a. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
    - b. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
    - c. Taco, Inc: [www.taco-hvac.com](http://www.taco-hvac.com).
  - 2. Steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VII-1; for 125 operating pressure.

### **2.03 STRAINERS**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
  - 2. Green Country Filtration: [greencountryfiltration.com](http://greencountryfiltration.com).
  - 3. WEAMCO: [www.weamco.com](http://www.weamco.com).
- B. Size 2 inch and Under:
  - 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
  - 1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
  - 1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

### **2.04 FLEXIBLE PUMP CONNECTORS**

- A. Manufacturers:
  - 1. Metraflex: [www.metraflex.com](http://www.metraflex.com).
  - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch (50 mm) and Under:
  - 1. Flexible connectors shall be of the braided stainless steel type. Flexible hose section to be 321 stainless steel, close pitch, annular corrugated hose with a braided outer covering of type 304 stainless steel. End connections to be carbon steel, male pipe thread. Overall length to allow for a minimum of 1/4" intermittent flexing, or per manufacturer's recommendations for additional motion.
- C. Size 2-1/2 inch (65 mm) and Larger:
  - 1. Flexible connectors shall be of the braided stainless steel type. Flexible hose section to be 321 stainless steel, close pitch, annular corrugated hose with a braided outer covering of type 304 stainless steel. End connections to be ANSI class 150 carbon steel plate flanges. Overall length to allow for a minimum of 3/8" intermittent flexing or per manufacturer's recommendations for additional motion.

## **2.05 SUCTION DIFFUSERS**

- A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

## **2.06 PRESSURE-TEMPERATURE TEST PLUGS**

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B. Application: Use extended length plugs to clear insulated piping.

## **2.07 RELIEF VALVES**

- A. Manufacturers:
  - 1. Tyco Flow Control: [www.tycoflowcontrol.com](http://www.tycoflowcontrol.com).
  - 2. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
  - 3. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
  - 4. Conbraco Industries: [www.apollovalves.com](http://www.apollovalves.com).
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blow down connection.
- G. Provide pump suction fitting on suction side of base mounted centrifugal pumps . Remove temporary strainers after cleaning systems.
- H. Support pump fittings with floor mounted pipe and flange supports.
- I. Pipe relief valve outlet to nearest floor drain.

**END OF SECTION**

**SECTION 23 21 23**  
**HYDRONIC PUMPS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. In-line circulators.
- B. Base mounted pumps.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Section 23 07 19 - HVAC Piping Insulation.
- E. Section 23 21 13 - Hydronic Piping.

**1.03 REFERENCE STANDARDS**

- A. UL 778 - Standard for Motor-Operated Water Pumps; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Goulds Pumps: [www.goulds.com](http://www.goulds.com)
- B. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
- C. Patterson Pumps: [www.pattersonpumps.com](http://www.pattersonpumps.com).
- D. Bell & Gossett [www.bellgossett.com](http://www.bellgossett.com).

**2.02 HVAC PUMPS - GENERAL**

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Minimum Quality Standard: UL 778.
- C. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

**2.03 IN-LINE CIRCULATORS**

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Non-ferrous keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.

- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling.

#### **2.04 BASE MOUNTED PUMPS**

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze or stainless steel casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze or stainless steel, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Verify that electric power is available and of the correct characteristics.

#### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Refer to Section 23 05 48.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base mounted pumps prior to start-up.
- H. Install close coupled and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
- I. Lubricate pumps before start-up.

**END OF SECTION**

**SECTION 23 51 00**  
**BREECHINGS, CHIMNEYS, AND STACKS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Category IV appliance venting

**1.02 RELATED REQUIREMENTS**

- A. Section 23 52 23 - Gas Fired Hydronic Boilers

**1.03 REFERENCE STANDARDS**

- A. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.
- B. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

**1.04 DEFINITIONS**

- A. Breeching: Vent Connector.
- B. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

**1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.
- D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

**1.06 REGULATORY REQUIREMENTS**

- A. Conform to NFPA 54 for installation of natural gas burning appliances and equipment.
- B. Conform to applicable code for installation of oil burning appliances and equipment.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Centrotherm, or approved equivalent.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

**2.02 FIELD FABRICATED BREECHINGS**

- A. IPEX System 636 CPVC for venting category IV appliances shall be:
  - 1. Vent shall be constructed with IPEX System 636 CPVC that shall meet or exceed the requirements of UL S636.
  - 2. Products furnished under this section shall conform to the requirements of NFPA 54 and NFPA 211, and shall comply with UL 1738, Standard for Venting Systems for Category II, III, and IV Gas-Burning Appliances, and all other applicable standards.
  - 3. Minimum wall thickness must be between 0.5 - 12".
  - 4. Joints to be sealed with factory supplied sealant. Joints shall be designed to minimize collection of condensate in both horizontal and vertical runs. Joints shall not use screws or other lesser alloy fasteners that penetrate the inner conduit.
  - 5. System is to be sized in accordance with the appliance manufacturer's specifications.

6. Contractor's provided flue/venting material must not exceed 100' of equivalent length (per each flue/vent). Contractor is to supply DEDC with the equivalent length data from the vent/flue material manufacturer.
- B. Minimum Metal Thicknesses based on SMACNA (DCS):
- C. Provide adjustable self-actuating barometric draft dampers, where indicated on drawings, full size of breeching.
- D. Reinforcing: Provide angle frames for rectangular breeching and flanged girth joints or angle frames for round breeching in accordance with SMACNA (DCS), at following intervals:

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Level and plumb chimney and stacks.
- G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

**END OF SECTION**

**SECTION 23 52 16**  
**CONDENSING BOILERS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

**1.03 RELATED REQUIREMENTS**

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 23 21 14 - Hydronic Specialties.
- C. Section 23 22 14 - Steam and Condensate Heating Specialties.
- D. Section 23 51 00 - Breechings, Chimneys, and Stacks.
- E. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

**1.04 REFERENCE STANDARDS**

- A. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2012.
- B. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2013.
- C. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.05 SUBMITTALS**

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
  - 1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted Boiler.
- B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50%, and 5% input firing rates at incoming water temperatures ranging from 60°F to 180°F. Test protocols shall conform to industry standards and shall be witnessed and reviewed by an independent, third-party group.
- C. Shop Drawings: For Boilers, Boiler trim and accessories, include:
  - 1. Plans, elevations, sections, details and attachments to other work
  - 2. Wiring Diagrams for power, signal and control wiring
- D. Source Quality Control Test Reports: Reports shall be included in submittals.
- E. Field Quality Control Test Reports: Reports shall be included in submittals.
- F. Operation and Maintenance Data: Data to be included in Boiler emergency, operation and maintenance manuals.
- G. Warranty: The complete warranty shall meet or exceed that described in Section 1.07 of 23 52 16 (below).
- H. Other Informational Submittals
  - 1. The Boiler shall bear the ASME stamped for 160 psi working pressure and shall be National Board listed.

### 1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. I=B=R Performance Compliance: Condensing Boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- C. ASME Compliance: Condensing Boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- E. DOE Compliance. Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- F. UL Compliance. Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

### 1.07 WARRANTY

- A. Standard Warranty: Boilers shall include 1 year warranty in which manufacturer agrees to repair or replace components of Boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers:
    - a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, mechanical defects or workmanship. This shall carry a 20-year warranty against thermal shock.
    - b. The burner shall carry a similar 5-year warranty
    - c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 1 year from acceptance.
- B. **Add Alternate #1: Extended Warrantee**
  - 1. Under this Add Alternate, the warrentee described in Section A (above) shall be extended by 2 additional years (effectively providing a 3-year extended warentee). This warranty must be manufacturer-approved.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis-of-Design Product: Camus Advantus Series (4000 MBH)
- B. Substitutions: See Section 01 60 00 - Product Requirements.

### 2.02 CONSTRUCTION

- A. Heat Exchanger: The heat exchanger shall be a fully welded 316L stainless steel, fire tube heat exchanger. The heat exchanger shall be designed for counter-flow. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The condensate collection basin shall be constructed of welded 316L stainless steel.
- B. Pressure Vessel: The Boiler water pressure drop shall not exceed than 2.9 ft at 379 gpm (for a 20 degree F delta T). The Boiler water connections shall be flanged 150-pound, ANSI rated. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code.
- C. The Boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column.
- D. The Boiler shall utilize an integrated controller operating through 4-20mA or 0-10Vdc for set point or fire-rate control. The control system shall have a display for Boiler set-up, Boiler status,

and Boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The Boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

- E. Modulating Air/Fuel Valve and Burner: The Boiler burner shall be capable of a 25 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen.
- F. The boiler shall be capable of thermal efficiency < 94.0%.

### **2.03 CONTROLS**

- A. The Boiler shall be equipped with a touch screen display, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay, and PC port connection. A secondary control that is field mounted outside or inside the appliance is not acceptable. The Boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The Boiler shall have a built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight Boilers of different Btu inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead Boiler every 24 hours. The control must be equipped with standard Modbus communication protocol with a minimum 55 readable points. The Boiler shall have a gateway device which will allow integration with BacNet (MSTP) protocols.
- B. This application shall utilize BacNet MSTP to communicate with the BAS system.
- C. The Boiler controller shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation.
- D. The Boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Tank Thermostat, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage.
- E. Boiler shall be provided with smart touch features.

### **2.04 ELECTRICAL POWER**

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the Boiler.

### **2.05 VENTING**

- A. Direct Vent system with side-wall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved CPVC sealed vent material terminating at the sidewall with the manufacturer's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe must be sealed and may be other materials listed in the Installation manual. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. Contractor responsible to provide equivalent lengths of selected venting systems (from manufacturer) prior to purchase of venting materials.

### **2.06 SOURCE QUALITY CONTROL**

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.

- B. Test and inspect factory-assembled Boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
  - 1. If Boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Before Boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting Boiler performance, maintenance and operations.
  - 1. Final Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where Boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 BOILER INSTALLATION**

- A. Install Boilers level on concrete bases. Concrete materials and installation requirements are specified in Division 03, Section 03 30 00 Cast in Place Concrete.
- B. Install gas-fired Boilers according to NFPA 54.
- C. Assemble and install Boiler trim.
- D. Install electrical devices furnished with Boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.
- F. Install factory provided condensate neutralization.

#### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to Boiler to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to Boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return Boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect venting full size to Boiler connections. Comply with requirements in Division 23, Section 23 51 31 "Breechings, Chimneys and Stacks."
- H. Ground equipment according to Division 26, Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26, Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

#### **3.04 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections

1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions. Provide factory equipment and controls start up and training for state personnel.
2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
  - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning parts and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests
  1. The Boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the Boiler manufacturer to complete the following performance tests:
    - a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
    - b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
    - c. Repeat tests until results comply with requirements indicated.
    - d. Provide analysis equipment required to determine performance.
    - e. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
    - f. Notify Project Manager, Commissioner, and Engineer in advance of test dates.
    - g. Document test results in a report and submit to Project Manager and Engineer.

**END OF SECTION**

**SECTION 26 05 01**  
**MINOR ELECTRICAL DEMOLITION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical demolition.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

**PART 2 PRODUCTS**

**2.01 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work: As specified in individual sections.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Delaware State University before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

**3.02 PREPARATION**

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Obtain permission from Delaware State University at least 24 hours before partially or completely disabling system.
  - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Notify Delaware State University before partially or completely disabling system.
  - 2. Notify local fire service.
  - 3. Make notifications at least 24 hours in advance.
  - 4. Make temporary connections to maintain service in areas adjacent to work area.

**3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK**

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.

- F. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

**3.04 CLEANING AND REPAIR**

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

**3.05 UNIVERSAL WASTE DIVERSION**

- A. Remove all universal waste from fixtures, panels, and related devices for proper diversion and reclamation.
- B. Universal waste components are as follows: electric motors, PCB ballasts, non PCB ballasts, capacitors, contactors, circuit breakers, elemental and liquid mercury containing articles, transformers, lead acid batteries, fluorescent light bulbs, and all HID light bulbs.
- C. Exemption: electric motors, circuit breakers, transformers and lighting contactors are exempt from this provision provided the contractor chooses to salvage or reuse the components.
- D. No identified universal waste will be discarded into the waste stream.

**END OF SECTION**

## SECTION 26 05 19

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wire and cable for 600 volts and less.
- D. Wiring connectors.

##### 1.02 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- F. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.
- G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- M. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- N. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

##### 1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

##### 1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

#### PART 2 PRODUCTS

##### 2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Concealed Dry Interior Locations: Use only building wire in raceway or metal clad cable.
- D. Exposed Dry Interior Locations: Use only building wire in raceway.

- E. Above Accessible Ceilings: Use only building wire in raceway or metal clad cable.
- F. Wet or Damp Interior Locations: Use only building wire in raceway.
- G. Exterior Locations: Use only building wire with Type THWN-2 insulation in raceway.
- H. Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- I. Use stranded conductors for control circuits.
- J. Use conductor not smaller than 12 AWG for power and lighting circuits.
- K. Use conductor not smaller than 14 AWG for control circuits.
- L. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
- M. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

## **2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS**

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
  - 1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
  - 2. Tinned Copper Conductors: Comply with ASTM B33.
- H. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
  - 3. Color Code:
    - a. Equipment Ground, All Systems: Green.

## **2.03 SINGLE CONDUCTOR BUILDING WIRE**

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
- E. Conductor: Copper.
- F. Insulation Voltage Rating: 600 volts.
- G. Insulation: NFPA 70, Type THHN/THWN.
- H. Insulation: Thermoplastic material rated 75 degrees C.

## **2.04 METAL-CLAD CABLE**

- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- B. Conductor Stranding:

1. Size 10 AWG and Smaller: Solid.
  2. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- E. Grounding: Full-size integral equipment grounding conductor.
- F. Armor: Steel, interlocked tape.
- G. Description: NFPA 70, Type MC.
- H. Conductor: Copper.
- I. Insulation Voltage Rating: 600 volts.
- J. Insulation Temperature Rating: 75 degrees C.
- K. Insulation Material: Thermoplastic.
- L. Armor Material: Steel.
- M. Armor Design: Interlocked metal tape.

## **2.05 WIRING CONNECTORS**

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Verify that field measurements are as shown on the drawings.
- F. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 PREPARATION**

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

### **3.03 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- C. Install metal-clad cable (Type MC) in accordance with NECA 120.
- D. Installation in Raceway:
  1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  2. Pull all conductors and cables together into raceway at same time.
  3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

- G. Terminate cables using suitable fittings.
  - 1. Metal-Clad Cable (Type MC):
    - a. Use listed fittings.
    - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- H. Install conductors with a minimum of 12 inches of slack at each outlet.
- I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- K. Make wiring connections using specified wiring connectors.
  - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 3. Do not remove conductor strands to facilitate insertion into connector.
  - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
- L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- M. Insulate ends of spare conductors using vinyl insulating electrical tape.
- N. Color Code Legend: Provide identification label identifying color code for ungrounded conductors at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- Q. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.
- R. Route wire and cable as required to meet project conditions.
  - 1. Wire and cable routing indicated is approximate unless dimensioned.
  - 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- S. Use wiring methods indicated.
- T. Pull all conductors into raceway at same time.
- U. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- V. Protect exposed cable from damage.
- W. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
- X. Use suitable cable fittings and connectors.
- Y. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- Z. Clean conductor surfaces before installing lugs and connectors.
- AA. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- AB. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

- AC. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- AD. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- AE. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

#### **3.04 FIELD QUALITY CONTROL**

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- E. Correct deficiencies and replace damaged or defective conductors and cables.
- F. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

**END OF SECTION**

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Grounding and bonding components.
- E. Provide all components necessary to complete the grounding system(s) consisting of:
  - 1. Existing metal underground water pipe.
  - 2. Metal underground water pipe.
  - 3. Metal frame of the building.
  - 4. Rod electrodes.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 03 30 00 - Cast-in-Place Concrete.

**1.03 REFERENCE STANDARDS**

- A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify exact locations of underground metal water service pipe entrances to building.
  - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
  - 3. Notify DEDC, LLC of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

**1.05 PERFORMANCE REQUIREMENTS**

- A. Grounding System Resistance: 5 ohms.

**1.06 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

**1.07 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.

**PART 2 PRODUCTS**

**2.01 GROUNDING AND BONDING REQUIREMENTS**

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
  - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by DEDC, LLC. Precipitation within the previous 48 hours does not constitute normally dry conditions.
  - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
  - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- E. Grounding Electrode System:
  - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    - a. Provide continuous grounding electrode conductors without splice or joint.
    - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
  - 2. Metal Building or Structure Frame:
    - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
  - 3. Ground Ring:
    - a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
    - b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
  - 4. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

## 2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
  - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
  - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

## 2.03 MANUFACTURERS

- A. Cooper Power Systems, a division of Cooper Industries: [www.cooperindustries.com](http://www.cooperindustries.com).

- B. Substitutions: See Section 01 60 00 - Product Requirements.

## **2.04 ELECTRODES**

- A. Manufacturers:
  - 1. Cooper Power Systems, a division of Cooper Industries: [www.cooperindustries.com](http://www.cooperindustries.com).
  - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Rod Electrodes: Copper-clad steel.
  - 1. Diameter: 3/4 inch.
  - 2. Length: 10 feet.
  - 3. Substitutions: See Section 01 60 00 - Product Requirements.

## **2.05 CONNECTORS AND ACCESSORIES**

- A. Mechanical Connectors: Bronze.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Make grounding and bonding connections using specified connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 05 53.
- E. Install ground electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
- F. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond steel together.
- G. Provide bonding to meet requirements described in Quality Assurance.
- H. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

**END OF SECTION**

## **SECTION 26 05 29**

### **HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

##### **1.02 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

##### **1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

##### **1.04 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

##### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.01 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 50%. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

- b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
  - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
  - 1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
  - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

**2.02 MANUFACTURERS**

- A. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- B. Threaded Rod Company: [www.threadedrod.com](http://www.threadedrod.com).
- C. Substitutions: See Section 01 60 00 - Product Requirements.

**2.03 MATERIALS**

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:

	Drop in Sleeve Anchors	Expansion Machine Bolt Anchors	Lag Shield Anchors	Nail-in Anchors	Toggle Bolts	Hollow Wall Anchors	Power Driven Studs
Brick	X	X	X	X			X
Concrete	X	X	X	X			X
Concrete Block	X		X	X	X		
Cinder Block		X			X	X	
Stone	X	X		X			X
Marble	X		X				
Building Tile		X			X	X	
Ceramic Tile		X			X		
Terrazzo		X		X			
Terra Cotta		X			X	X	
Plaster					X	X	
Drywall				X	X		
Slate		X			X		
Steel							X

**ANCHOR HARDWARE TABLE**

- D. Formed Steel Channel:
  - 1. Product: Steel "U" shaped with in-turned clamping ridges manufactured by Unitstrut, Power Wtrut, B-Line Strut or Kindorf.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by DEDC, LLC, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by DEDC, LLC, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
  - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

**END OF SECTION**

**SECTION 26 05 34**  
**CONDUIT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. Intermediate metal conduit (IMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Conduit fittings.
- G. Conduit, fittings and conduit bodies.

**1.02 REFERENCE STANDARDS**

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- J. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- K. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- L. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- M. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

**1.04 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

## **PART 2 PRODUCTS**

### **2.01 CONDUIT APPLICATIONS**

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- D. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- E. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- F. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- G. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- H. Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit.
  - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
  - 3. Maximum Length: 6 feet unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:
    - a. Motors.

### **2.02 CONDUIT REQUIREMENTS**

- A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

### **2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.
  - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

### **2.04 INTERMEDIATE METAL CONDUIT (IMC)**

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.
  - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
- C. Conduit Size: Comply with NFPA 70.

1. Minimum Size: 3/4 inch 1/2 inch unless otherwise specified.
- 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; 1/2 inch for conduits crossing each other.
- F. Wet and Damp Locations: Use rigid steel conduit.
- G. Dry Locations:
  1. Concealed: Use electrical metallic tubing, where permitted by the NEC.
  2. Exposed: Use electrical metallic tubing, where permitted by the NEC.

## **2.05 METAL CONDUIT**

- A. Manufacturers:
  1. Allied Tube & Conduit: [www.alliedtube.com](http://www.alliedtube.com).
  2. Wheatland Tube Company: [www.wheatland.com](http://www.wheatland.com).
  3. Triangle
  4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

## **2.06 FLEXIBLE METAL CONDUIT (FMC)**

- A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- B. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel or malleable iron.
- C. Description: Interlocked steel construction.
- D. Fittings: NEMA FB 1.

## **2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)**

- A. Manufacturers:
  1. AFC Cable Systems, Inc: [www.afcweb.com](http://www.afcweb.com).
  2. Electri-Flex Company: [www.electriflex.com](http://www.electriflex.com).
  3. International Metal Hose: [www.metalhose.com](http://www.metalhose.com).
  4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel or malleable iron.
- D. Description: Interlocked steel construction with PVC jacket.
- E. Fittings: NEMA FB 1.

## **2.08 ELECTRICAL METALLIC TUBING (EMT)**

- A. Manufacturers:
  1. Allied Tube & Conduit: [www.alliedeg.com](http://www.alliedeg.com).
  2. Wheatland Tube Company: [www.wheatland.com](http://www.wheatland.com).
  3. Triangle
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

- C. Fittings:
  - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.
  - 3. Connectors and Couplings: Use compression (gland) or set-screw type.
    - a. Do not use indenter type connectors and couplings.
- D. Description: ANSI C80.3; galvanized tubing.
- E. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron compression type.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

#### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Conduit Support:
  - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- F. Connections and Terminations:
  - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  - 3. Use suitable adapters where required to transition from one type of conduit to another.
  - 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
  - 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  - 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  - 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- G. Penetrations:
  - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
  - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  - 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  - 4. Conceal bends for conduit risers emerging above ground.
  - 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.

6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
  8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- H. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where conduits are subject to earth movement by settlement or frost.
- I. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- J. Provide grounding and bonding in accordance with Section 26 05 26.

### **3.03 INTERFACE WITH OTHER PRODUCTS**

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Section 01700.

**END OF SECTION**

**SECTION 26 05 37**  
**BOXES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.
- D. Pull and junction boxes.

**1.02 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 1).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

**1.04 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.

**PART 2 PRODUCTS**

**2.01 BOXES**

- A. General Requirements:
  - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  3. Use suitable concrete type boxes where flush-mounted in concrete.
  4. Use suitable masonry type boxes where flush-mounted in masonry walls.
  5. Use raised covers suitable for the type of wall construction and device configuration where required.
  6. Use shallow boxes where required by the type of wall construction.
  7. Do not use "through-wall" boxes designed for access from both sides of wall.
  8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
  12. Wall Plates: Comply with Section 26 27 26.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
  3. Junction and Pull Boxes Larger Than 100 cubic inches:
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

## 2.02 MANUFACTURERS

- A. Appleton Electric: [www.appletonelec.com](http://www.appletonelec.com).
- B. Hoffman
- C. Steel City
- D. Crouse-Hinds
- E. Substitutions: See Section 01 60 00 - Product Requirements.

## 2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
- B. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- C. Wall Plates for Finished Areas: As specified in Section 26 27 26.

## 2.04 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
  1. Material: Galvanized cast iron.
  2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Supports:
  - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- E. Install boxes plumb and level.
- F. Flush-Mounted Boxes:
  - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
  - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
  - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- G. Install boxes as required to preserve insulation integrity.
- H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 05 26.
- M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- O. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- P. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
  - 1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- Q. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- R. Maintain headroom and present neat mechanical appearance.
- S. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- T. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- U. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- V. Use flush mounting outlet box in finished areas.
- W. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- X. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

- Y. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- Z. Do not fasten boxes to ceiling support wires.
- AA. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AB. Use gang box where more than one device is mounted together. Do not use sectional box.
- AC. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- AD. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

**3.02 ADJUSTING**

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

**3.03 CLEANING**

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

**END OF SECTION**

**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Large Device Identification.
- C. Nameplates and Labels.
- D. Wire and cable markers.
- E. Voltage markers.
- F. Warning signs and labels.

**1.02 REFERENCE STANDARDS**

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION REQUIREMENTS**

- A. Identification for Equipment:
  - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
- B. Identification for Conductors and Cables:
  - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
  - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

**2.02 MANUFACTURERS**

- A. Brady Corporation: [www.bradycorp.com](http://www.bradycorp.com).
- B. Substitutions: See Section 01 60 00 - Product Requirements.

**2.03 LARGE DEVICE IDENTIFICATION**

- A. Identify all disconnect switches, pull boxes, junction boxes (larger than 4" X 4") in unfinished areas with Brady voltage markers, catalog #B-498, series #44xxx (xxx indicates last 3 numbers of model number which vary based on voltage, size, etc. Contractor shall coordinate this information prior to ordering). Sizes for each label shall be as large as possible, style "A", "B" or "C" as the device permits.
- B. Identify all disconnect switches, pull boxes, junction boxes (larger than 4" X 4") finished with black engraved lamicaid self-adhesive labels, 1" X 4". The label shall state the power feed, circuit or section number, and the equipment identification number that the large device serves.

**2.04 IDENTIFICATION NAMEPLATES AND LABELS**

- A. Identification Nameplates:
  - 1. Materials:

2. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
  1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
  2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Nameplates: Engraved three-layer laminated plastic, black letters on white background, 2" by 6" in size
- D. Locations:
  1. Each electrical distribution and control equipment enclosure.
  2. Disconnect Switches
  3. Panelboards.
- E. Letter Size:
  1. Use 1/8 inch letters for identifying individual equipment and loads.
- F. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) white letters on black background. Use only for identification of individual wall switches and receptacles, and control device stations.

## **2.05 WIRE AND CABLE MARKERS**

- A. Manufacturers:
  1. Brady, Bradysleeve, Catalog #B-320 PVC.
  2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.
- H. Locations: Each conductor at pull boxes, junction boxes, and Termination or connection points including each load connection.
- I. Legend:
  1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

## **2.06 VOLTAGE MARKERS**

- A. Minimum Size:
- B. Legend:
- C. Color: Black text on orange background unless otherwise indicated.
- D. Location: Furnish markers for each conduit longer than 6 feet.
- E. Spacing: 20 feet on center.

## **2.07 WARNING SIGNS AND LABELS**

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
  1. Materials:
  2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.
- B. Degrease and clean surfaces to receive nameplates and labels.

#### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  1. Surface-Mounted Equipment: Enclosure front.
  2. Flush-Mounted Equipment: Inside of equipment door.
  3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  4. Elevated Equipment: Legible from the floor or working platform.
  5. Interior Components: Legible from the point of access.
  6. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

**END OF SECTION**

**SECTION 26 27 17**  
**EQUIPMENT WIRING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical connections to equipment.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 34 - Conduit.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 05 37 - Boxes.
- D. Section 26 27 26 - Wiring Devices.

**1.03 REFERENCE STANDARDS**

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
  - 2. Determine connection locations and requirements.
- B. Sequencing:
  - 1. Install rough-in of electrical connections before installation of equipment is required.
  - 2. Make electrical connections before required start-up of equipment.

**1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

**1.06 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
  - 1. Colors: Conform to NEMA WD 1.
  - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
  - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Wiring Devices: As specified in Section 26 27 26.
- C. Flexible Conduit: As specified in Section 26 05 34.
- D. Wire and Cable: As specified in Section 26 05 19.

- E. Boxes: As specified in Section 26 05 37.

## **2.02 EQUIPMENT CONNECTIONS**

- A. Water Source Heat Pumps
- B. HVAC Pumps
- C. Electric Hot Water heaters

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

### **3.02 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. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

**END OF SECTION**

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 37 - Boxes.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).
- E. NEMA WD 6 - Wiring Device -- Dimensional Specifications; National Electrical Manufacturers Association; 2002 (R2008).
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

**1.05 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Hubbell Incorporated; \_\_\_\_\_: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
- B. Pass & Seymour, a brand of Legrand North America, Inc; \_\_\_\_\_: [www.legrand.us](http://www.legrand.us)
- C. Cooper Wiring Devices: [www.cooperwiringdevices.com](http://www.cooperwiringdevices.com).
- D. Leviton Manufacturing, Inc: [www.leviton.com](http://www.leviton.com).
- E. Substitutions: See Section 01 60 00 - Product Requirements.

## 2.02 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Finishes:

## 2.03 WALL SWITCHES

- A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Wall Switches: Extra Heavy Duty Industrial Series, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
  - 1. Body and Handle: Ivory plastic with toggle handle.
  - 2. Ratings:
    - a. Voltage: 120 volts, AC.
    - b. Current: 20 amperes.
- C. Switch Types: Single pole, 3-way, and 4-way.

## 2.04 RECEPTACLES

- A. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Receptacles: Extra Heavy Duty Industrial Series, complying with NEMA WD 6 and WD 1.
  - 1. Device Body: Ivory plastic.
  - 2. Configuration: NEMA WD 6, type as specified and indicated.
- C. Convenience Receptacles: Type 5-20R.
- D. Single Convenience Receptacles.
- E. Duplex Convenience Receptacles.
- F. GFCI Receptacles: 5-20R Duplex Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

## 2.05 WALL PLATES

- A. All Wall Plates: Comply with UL 514D.
  - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  - 2. Size: Standard.
  - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Decorative Cover Plates: , Smooth stainless steel.
- C. Weatherproof Cover Plates: Gasketed cast metal with gasketed device cover.
- D. Surface Mounted Device Wall Plates: Stamped steel.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.

- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### **3.03 INSTALLATION**

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- I. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- O. Install receptacles with grounding pole on bottom.
- P. Connect wiring device grounding terminal to outlet box with bonding jumper.
- Q. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- R. Connect wiring devices by wrapping conductor around screw terminal.
- S. Install galvanized steel cover plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted switches & outlets.

### **3.04 INTERFACE WITH OTHER PRODUCTS**

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights specified.
- B. Install wall switch 48 inches above finished floor.
- C. Install convenience receptacle 18 inches above finished floor.

- D. Install convenience receptacle 6 inches above counter.
- E. Install telephone jack 18 inches above finished floor.
- F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.
- G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

**3.05 FIELD QUALITY CONTROL**

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Operate each wall switch with circuit energized and verify proper operation.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

**3.06 ADJUSTING**

- A. Adjust devices and wall plates to be flush and level.

**3.07 CLEANING**

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**END OF SECTION**

**SECTION 26 28 17**  
**ENCLOSED CIRCUIT BREAKERS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Enclosed circuit breakers.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.

**1.05 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Maintain one copy of each document on site.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. General Electric Company: [www.geindustrial.com](http://www.geindustrial.com).

**2.02 ENCLOSED CIRCUIT BREAKERS**

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
  2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
- E. Conductor Terminations: Suitable for use with the conductors to be installed.
- F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
- H. Provide externally operable handle with means for locking in the OFF position.

### **2.03 MOLDED CASE CIRCUIT BREAKERS**

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
    - a. 14,000 rms symmetrical amperes at 480 VAC.
  2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
- E. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- F. Molded Case Circuit Breakers: UL listed for the following service conditions:

### **2.04 TRIP UNITS**

- A. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 600 amperes and larger with mechanism for adjusting long time continuous current, short time pickup current setting for automatic operation.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide identification nameplates for each enclosed circuit breaker in accordance with Section 26 05 53.

- I. Provide arc flash warning labels in accordance with NFPA 70.

**3.02 FIELD QUALITY CONTROL**

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Tests listed as optional are not required.
- D. Correct deficiencies and replace damaged or defective enclosed circuit breakers.
- E. Perform field inspection and testing in accordance with Section 01 40 00.
- F. Inspect and test each circuit breaker.
- G. Inspect each circuit breaker visually.
- H. Perform several mechanical ON-OFF operations on each circuit breaker.
- I. Verify circuit continuity on each pole in closed position.
- J. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
- K. Include description of testing and results in test report.

**3.03 ADJUSTING**

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

**END OF SECTION**

**SECTION 26 29 13**  
**ENCLOSED CONTROLLERS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Manual motor controllers.
- B. Combination magnetic motor controllers and disconnects.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; National Electrical Manufacturers Association; 2000 (R2005), with errata, 2008.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 SUBMITTALS**

- A. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

**1.05 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Schneider Electric; Square D Products; Model \_\_\_\_\_: [www.schneider-electric.us](http://www.schneider-electric.us).
- B. Hubbell Wiring.

**2.02 MANUAL CONTROLLERS**

- A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, NO auxiliary contact, and push button operator.
- B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and key operator.
- C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and key operator.

**2.03 DISCONNECTS**

- A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.
- B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.

B. Provide supports in accordance with Section 26 05 29.

**END OF SECTION**

**SECTION 26 51 00**  
**INTERIOR LIGHTING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Interior luminaires.
- B. Ballasts and drivers.
- C. Lamps.

**1.02 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1598 - Luminaires; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each fixture that is not a standard product of the manufacturer.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.04 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 70 and NFPA 101.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS - LUMINAIRES**

- A. Columbia Lighting: [www.Columbialighting.com](http://www.Columbialighting.com).
- B. Substitutions: See Section 01 60 00 - Product Requirements, except where individual luminaire types are designated with substitutions not permitted.

**2.02 LUMINAIRES**

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

### **2.03 LUMINAIRES**

- A. Furnish products as indicated in Schedule included on the Drawings.

### **2.04 BALLASTS AND DRIVERS**

- A. All Ballasts:
  - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
  - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

### **2.05 LAMPS**

- A. Manufacturers:
  - 1. GE Lighting: [www.gelighting.com](http://www.gelighting.com).
  - 2. Philips Lighting Co of NA: [www.lighting.philips.com](http://www.lighting.philips.com).
  - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Lamps - General Requirements:
  - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
  - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
  - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
  - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the DEDC, LLC to be inconsistent in perceived color temperature.
- C. Lamp Types: As specified for each fixture.
- D. Fluorescent Lamps:

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- F. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- G. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- H. Install accessories furnished with each luminaire.
- I. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within fixture; use flexible conduit.
- J. Connect luminaires to branch circuit outlets provided under Section 26 05 37 using flexible conduit.

- K. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Install specified lamps in each luminaire.
- N. Install lamps in each luminaire.

**3.02 FIELD QUALITY CONTROL**

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Perform field inspection in accordance with Section 01 40 00.
- D. Operate each luminaire after installation and connection to verify proper operation.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by DEDC, LLC.

**3.03 ADJUSTING**

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by DEDC, LLC. Secure locking fittings in place.
- B. Aim and adjust fixtures as directed.

**3.04 CLEANING**

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosures.
- D. Clean finishes and touch up damage.

**3.05 PROTECTION**

- A. Relamp luminaires that have failed lamps at Substantial Completion.

**3.06 SCHEDULE - SEE DRAWINGS**

**END OF SECTION**